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Targeting adolescents as agents of change for an entomophageous future

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Abstract

As food supply practices must adapt to the reality of limited natural resources, alternative solutions must be found to meet the dietary needs of a growing world population. Edible insect consumption represents a sustainable substitute to that of conventional meat. Psychological barriers are largely responsible for dictating Westerners' aversion towards insect eating. As adolescents have been less exposed to socio-cultural constructs and as their food habits are less entrenched, they might express a greater openness towards edible insect products. This study aims to assess the impact of exposure and familiarisation with edible insects on adolescents' attitudes towards entomophagy. Between February 2018 and January 2020, 662 students aged 15–16 years from a Canadian high school engaged in a pedagogical insect farming project during which they had the chance to learn about insects as a sustainable foodstuff, while being familiarised with insect farming methods. Three different student cohorts took part in this project. The first and second had the opportunity to raise crickets and the third mealworms. Relying on surveys distributed before and after these 3 month projects, time-based and type-based analyses regarding students' initial attitudes towards edible insects and their evolution over the course of these activities were performed. Results showed that the project greatly enhanced their acceptance towards edible insect consumption, suggesting that the speed

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and impact of peer influence amongst adolescents could be leveraged in promotional efforts to accelerate the adoption of edible insects.

KEYWORDS

edible insects, entomophagy, food pedagogy, sustainability

Key insights**What is the main issue that the paper addresses?**

This paper addresses how exposure and familiarization with edible insects can affect adolescents' attitudes towards entomophagy. Adolescents' lower exposure to socio-cultural constructs and their less entrenched food habits might facilitate their openness towards edible insect consumption.

What are the main insights that the paper provides?

A pedagogical insect farming project involving 662 students from a Canadian high school had a significant positive effect on participants' acceptance towards edible insects. It suggests that the speed and impact of peer influence amongst adolescents could be leveraged in promotional efforts aiming to accelerate the adoption of edible insects.

INTRODUCTION

Demographic growth and dietary transitions are increasing the global demand for protein-dense foods. The meat production industry is already pushing nature's limits beyond capacity: almost 80% of all agricultural land is used for farming and feeding livestock, which provide only 20% of the calories produced for human consumption (Alexander et al., 2016). Livestock farming is the main driver of deforestation, which is linked to the rise of newly transmitted diseases such as zoonotic viruses (de Sadeleer & Godfroid, 2020). Hence, food supply and consumption practices must adapt to the reality of environmental constraints. To support the thriving of future generations, a central place in political agendas must be directed towards supporting more ethically oriented food consumption practices—ones that are in line with food security and sustainability. Inspired by naturally occurring processes, entomophagy (i.e. insect consumption) and entotechnologies (i.e. sustainable insects farming practices) are being depicted as a holistic solution to alleviate the ecological impacts tied with conventional livestock. This idea is surely intriguing, and it can serve as a medium to raise awareness regarding sustainability challenges within the food industry.

Like most animals, insects contain high levels of complete proteins: a well-balanced combination of each of the nine essential amino acids required for the human body to thrive (Raheem et al., 2019). Insects are typically rich in mono- and polyunsaturated as well as omega-3 fatty acids (Ghosh et al., 2017) and in a variety of minerals and vitamins such as zinc, iron and magnesium (Rumpold & Schlüter, 2013). Moreover, simulated *in vitro* digestion experiments revealed that edible insects could modulate the microbiome composition, which

may exert positive anti-inflammatory effects on the human gut flora (Young et al., 2020). With the rising social significance of dietary health and sustainability issues, younger generations are quickly acquiring a sense of the wide-ranging impacts of their everyday food choices (Ojala, 2016). Familiarising adolescents with insect farming and eating at school might prove particularly promising in generating changes in collective attitudes and behaviours towards entomophagy.

Edible insects for a sustainable diet

In the past decade, edible insects have been portrayed by the Food and Agriculture Organisation as a viable solution to global food insecurity (van Huis et al., 2013), and their potential for supporting sustainable food systems has been recognised (Halloran et al., 2018). To cope with societies' increasing pressure on ecosystems, it appears important to review our conception of the urban foodscape. Food production and transformation industries within cities generate large amounts of traceable pre-consumer organic waste, a potentially highly valuable resource for insect producers. Circular edible insect farming methods can upcycle these wastes through insect diets, thus fighting food waste and reducing the carbon footprint associated with putrescible materials' poor management practices (Cabrera et al., 2015). While bioconverting these raw materials, cities can produce sustainable animal proteins, therefore improving both food security and sovereignty at a very local scale (Rumpold & Langen, 2020). Relocating more food production activities within cities alleviates the pressure on transportation systems, while facilitating urban dwellers' access to fresh foods. However, switching conventional livestock for bugs should not be seen as a panacea. It remains critical to address systemic issues in order to ensure the sustainability and resilience of food systems, that is their ability to support regenerative agricultural practices (i.e. preserving natural habitats and biodiversity) through inclusive supply chains that rightly support the thriving of community-scale enterprises.

Although entomophagy is recognised as a traditional practice in societies representing about a quarter of the world population (van Huis, 2016), strong psychological barriers are hampering many consumers' willingness to adopt insects in their diet—namely their strong association with decaying food, disease spreading, harvest destruction and unwanted domestic intruders (Looy et al., 2014). For insects to be perceived as culturally edible and to reduce the aversions linked to danger and disgust (Rozin et al., 2008), strategies put forward must contribute to modifying individual and social mental representations. Many Westerners are familiar with insects, but perhaps not as ingredients to incorporate into their diets. As they are a radically new product that challenges traditional cognitive patterns, edible insects represent a discontinuous food innovation (Robertson, 1971), dissemination of which depends largely on consumers' imitation behaviour (Rogers, 2003). Adolescents have a strong influence over their peers and family members. They are responsible for more than half of all new products entering their households (Brée, 2012), and influence up to 80% of their household food budget (Hunter, 2002). Therefore, efforts that focus on adolescents to accelerate the widespread adoption of entomophagy might prove highly effective in quickly altering social representations of insects as food. Moreover, since adolescents' eating habits are less entrenched, they often tend to be less reluctant towards new foods (Tuorila et al., 2001). Hence, tactics designed to train future entomophagists may prove particularly promising. As food aversions and preferences tend to remain relatively stable during adulthood (Rigal, 2010), it appears important to alleviate consumers' reluctance towards entomophagy at a young age.

Alleviating psychological barriers

When confronted with the ecological, social, and nutritional benefits of edible insects, some consumers face a cognitive dissonance, as it appears incompatible with their own dietary preferences. Insects reach all three reasons for food refusal, simultaneously evoking aversion (fear mixed with anxiety), danger and disgust (Rozin et al., 2008). Aversion is typically linked to food neophobia, a cognitive reluctance towards unknown foods as a psychological defence mechanism against poisoning (Martins & Pliner, 2006). If some insects can indeed be toxic, over 2000 species are known to be edible for humans (van Huis et al., 2013). In fact, owing to their extremely rich nutritional profile (often compared with conventional meat; Payne et al., 2016), some farmers even grow crops with the main goal of attracting and harvesting insects rather than the crops themselves (FAO, 2010). As for disgust, it can be described as an irrational primary emotion that manifests itself in response to associations most often dictated by prevailing cultural norms (La Barbera et al., 2018). Indeed, beliefs associated with the nature or origin of food are largely driven by social constructs (Haidt et al., 1994). They can create strong reluctance towards unfamiliar products. Hence, reluctance towards edible insects is both innate and acquired, in the sense that it is influenced by biological factors and cultural heritage as well (Fischler & Chiva, 1985). The latter is constructed mainly during childhood and adolescence, influenced by the various communities of belonging to which individuals have been grafted (Chiva, 2001).

As revealed by Lewin (1943)—largely responsible for popularising studies pertaining to group dynamics (Borek & Abraham, 2018)—resistance to change stems from the fear of deviating from standards dictated by one's social circle. Therefore, entomophagy promotion could be facilitated by group-based actions, such as carrying discussions and other activities aiming to generate changes in collective behaviour. According to *social cognitive theory*, learning that occurs in a social context and supports reciprocal interactions and dynamic experiences amongst participants emphasises external and internal forces leading to the acquisition of self-efficacy and collective agency, which can prove successful in maintaining behaviours (Bandura, 1986). Although many studies have proposed more detailed processes of group dynamics leading to achieve behavioural changes amongst participants (Bartholomew et al., 2016; Gillies & Ashamn, 2003; Michaelsen et al., 2004), the three phases initially identified by Lewin (1943) offer a very general overview that is still recognised nowadays and forms the basis of most contemporary theories: (1) reflection leading to the abandonment of initial behaviours; (2) experimentation with new practices; and (3) the integration of new habits.

Critical food pedagogy

Following the *theory of planned behaviour*, behavioural change can be achieved by increasing one's motivational drivers while developing the sense of ability (Ajzen, 1991). *Critical food pedagogy* is an approach aiming to address the impacts of dietary choices on human health, social justice, and ecological sustainability, while recognising the components inherent to sustainable food systems (Sumner, 2015). Increasing food literacy amongst adolescents can help support the adoption of healthy dietary behaviours and, with parents not always holding the required knowledge or teaching skills, the classroom appears as the ideal setting to address these issues (Ronto et al., 2016). It is also a means to trigger adolescents' interest and engagement willingness for a broad range of topics that have become popular and important in post-secondary educational agendas as well as campus student groups (e.g. food security, social and economic inequalities, political solidarity, biodiversity, pollution; Classens & Sytsma, 2020). Following an approach centred on critical food pedagogy might help more

efficiently communicate the benefits associated with entomophagy, which has been shown to positively affect consumers' intent to try (Verneau et al., 2016).

Beyond enhancing motivational determinants through knowledge sharing, addressing possible alternative dietary practices can help generate a greater sense of empowerment (Contento, 2015). Embodied pedagogical learning combines thought with action and involves the training of specific capacities (Flowers & Swan, 2012). *Farm to School* programmes—an integrative praxis combining *critical food pedagogy* with the acquisition of applied farming skills—have been found particularly effective in generating behavioural change (Bontrager, 2014; Moss et al., 2013). They have been associated with a successful decrease in participants' neophobia, an increase in their self-efficacy regarding the ability to make mindful food choices and an alteration of social norms regarding (un)desirable foods (Koch, 2015). According to Share and Stewart-Knox (2012), the sensitive period during which unhealthy habits have greater potential to develop and when nutrition education may prove the most useful is between the age of 14 and 17.

For Westerners to perceive insects as an actual foodstuff, strategies aiming to overcome reluctance should be directed towards modifying individual and social mental representations. Besides marketing strategies that can contribute to alleviating such consumer-level barriers (Marquis et al., 2020), exposure and familiarisation have been identified as avenues that can help further overcoming reluctance towards edible insects (Tan et al., 2015). Pedagogical edible insect farming activities in schools hold the potential for creating enjoyable learning environments to address food and nutrition issues, while providing knowledge about how to farm and cook with insects. Such activities—supported by enhanced exposure and trial opportunities—could lead to the successful recognition of the nutritional benefits and palatability associated with insects, while possibly even overturning reluctant behaviours and increasing trial willingness amongst adolescents (Martins & Pliner, 2006; Reverdy et al., 2008).

With researchers facing specific challenges and dilemmas when involving young subjects in their investigation (Best, 2007), past research delving into strategies to overcome consumer reluctance towards entomophagy has largely focused on adults. This study attempts to fill the gap in the applied scientific literature on the benefits of involving adolescents in efforts to support the growing popularisation of entomophagy (Jones, 2020). The research question it aims to answer is whether insect school farming programmes centred on critical food pedagogy can help alleviate adolescents' psychological barriers towards entomophagy.

MATERIALS AND METHODS

Research design

Between February 2018 and January 2020, 662 fourth-grade high school students (15–16 years old) divided into three cohorts of a science and technology programme took part in the project. The participating school was situated in the Montreal (Quebec, Canada) suburbs. Written parental approval was required (i.e. by replying to an email that was sent by the institution) in order for students to be allowed to participate in the project. Parents were informed that people allergic to crustaceans might also suffer allergic reactions if consuming insects (Verhoeckx et al., 2014). The very few students who either refused to participate or failed to obtain this approval did not complete the surveys or engage in insect farming activities. At the beginning of the project, students attended a 30 min presentation about the potential of edible insects in promoting a sustainable diet for both humans and animals. When the insect farms were delivered, the author of the present research provided participating teachers and students with information on insect rearing methods and materials to ensure

the welfare of the insects involved (e.g. handling, temperature, humidity, feeding, rearing densities, reproduction, frass sifting and freeze-slaughtering). During the following weeks and over a 3 month period, students had the opportunity to engage with insect farming in class. The teachers sporadically led a dozen mini-workshops in the form of group activities to introduce students to basic notions of insect biology, farming methods and entomophagy (e.g. nutritional and environmental needs, reproductive cycle, harvesting, processing, and cooking). The first and second cohorts had to take care of small cricket farms while the last was offered the opportunity to raise mealworms, thus allowing both time-based and type-based analyses to be performed. At the end of the project, professors had organised tasting activities using both commercially available insect-based foods (whole seasoned, sweet bars and pasta) as well as homemade brownies (cooked by the professors, using commercial insect flour), so that students willing to try edible insect products were given the chance to do so. This research was conducted in compliance with the ethical guidelines of Concordia University for research involving human subjects (certificate number 3007979).

Questionnaires

Pre- (A) and post- (B) project surveys based on closed (yes or no), multiple-choice, five-point Likert scale (not at all; not really; undecided; yes, moderately; yes, very), and short answers were used for data collection. Online surveys (*Google Forms*) were compiled in class by the students on their personal laptops/tablets and under the supervision of their teachers. The participating high school being francophone, the questions were formulated in French (see Appendix [S1A](#)). The questions aimed to assess: (1) participants' initial degree of food neophobia (10 questions; Pliner & Hobden, 1992); (2) their knowledge, acceptance, and behaviours towards entomophagy and insect farming; (3) the evolution of their acceptance towards edible insects over the course of the project; (4) their beliefs regarding the future of entomophagy; (5) their preferences for insect-based products; and (6) the influential impact towards their peers. Students also had to indicate their gender and country of origin, and were given the opportunity to provide any additional statement. At the end of the surveys, participants were asked to respond to four questions regarding how they felt about the idea of having an insect farm in class (survey A) and how they found the experience (survey B).

Participants and country of origin

The number of students in the three cohorts completing the initial survey were respectively 216 (62.9% females) in February 2018 (A1), 209 (67.6% females) in October 2018 (A2), and 237 (65.5% females) in September 2019 (A3). Thirteen students either did not relate to any gender or chose not to disclose this information. To assess the effect that respondents' different cultural backgrounds could have on their attitudes and behaviours relating to entomophagy, they were grouped into five categories according to their country of origin: 72.8% were from Canada or the United States (CanUS, with only four US students), 7.3% were from Asia, 6.5% were from Africa (Afr), 5.9% were from Europe (Eur) and 2.9% were from Latin America or the Caribbean (LAC). The rest of them (4.7%) refused to answer. The number of students participating in the post-project surveys were 223 (63% females) in May 2018 (B1), 172 (68% females) in January 2019 (B2) and 221 (67.3% females) in January 2020 (B3). This time, 23 students did not relate to any gender or chose not to disclose their gender. As surveys were answered in class, the number of respondents varies in the A and B surveys (662 vs. 616 respondents, with one student group from the second cohort not completing the post-project survey owing to a lack

of time in class). The questionnaires did not allow to match respondents in the A and B surveys.

Data analyses

Statistical analyses were performed using SPSS software: frequency and descriptive tables, independent samples *t*-tests, cross-tabulations (chi-squares), and one-way ANOVAs. Data were considered statistically different if $p < 0.05$. Charts were also built using the same software. As the last question (additional statement) was an open one, responses were manually categorised to fit with the subsections of the present article. The most relevant or repeating comments were translated and mentioned in the results section as supporting elements (fictive names that adequately reflect respondents' gender). Original answers in French can be found in Appendix S1B.

FINDINGS

Initial degree of food neophobia

In the survey A, 10 questions (see Table 1) assessed students' degree of food neophobia (the Food Neophobia Scale, or FNS) using a five-point scale (Verbeke, 2015). Therefore, the maximum possible neophobia score for this survey was 50. The two questions (five and 10) using the terms 'ethnic' in their original 1992 formulation to qualify foods and restaurants originating from other countries were translated into French using the word 'étrangère', whose connotation appears less disputable.

The FNS showed a Cronbach alpha value of 0.873, indicating a high degree of internal validity. Performing a factor analysis using the Varimax rotation method with a Kaiser normalisation revealed that FNS questions could be divided into two factors: questions 1, 4, 6, 8, 9 and 10 (factor 1, explaining 35.7% of the variance) and questions 2, 3 and 7 (factor 2, explaining 20.4% of the variance). Question 5 was absent from both these groups as its factor was inferior to 0.5. A similar categorisation of questions has also been observed by Olabi et al. (2009), who explained it by observing that the factors seemed to differentiate questions relating to 'apprehension with regard to trying novel and ethnic foods' (regular questions) vs. those relating to the 'interest in trying new foods' (reversed questions) (Olabi et al., 2009). Indeed, questions 1, 4,

TABLE 1 Questions and participants' mean scores to the questions relating to food neophobia.

Questions (R = reverse coded)	Mean	SD	Factor 1	Factor 2
1. I like trying new and different foods (R)	2.11	0.99	0.786	0.236
2. I do not trust unknown foods	3.11	1.13	0.236	0.749
3. If I do not know what is in a food, I will not try it	2.87	1.20	0.028	0.760
4. I like foods from different countries (R)	1.92	0.98	0.761	0.038
5. 'Ethnic' food looks too weird to eat (discarded)	1.96	0.94	0.412	0.436
6. At dinner parties, I am ready to try new foods (R)	1.64	0.88	0.693	0.223
7. I am afraid to eat things I have never had before	2.37	1.20	0.439	0.636
8. I am very particular about the foods I eat	2.47	1.20	0.617	0.299
9. I will eat almost anything (R) (discarded)	2.67	1.29	0.667	0.319
10. I like to try new 'ethnic' restaurants (R)	1.87	1.05	0.809	0.090

6, 9, and 10 have a reverse formulation, meaning that positive answers are linked to neophilia rather than neophobia. Therefore, these responses were reverse coded.

Data analysis revealed an average score of 22.92/50 (or 32/70), with a standard deviation (SD) of 7.16. When comparing female and male participants, no significant difference in their FNS score was observed ($p=0.806$). As suggested by Pliner and Hobden (1992), in order to classify respondents based on their degree of neophobia, those showing a FNS score that was over the SD ($>30/50$) were categorised as high neophobes (HNp, 13.8%) while those showing a FNS score that was below the SD ($<16/50$) were categorised as low neophobes (LNp, 13.6%), the remainder forming the mildly neophobic category (MNp, 72.6%) (Table 2). The distribution of neophobia categories was found to be correlated ($p=0.054$) with respondents' region of origin (Figure 1).

As mentioned by one participant, allergies or food intolerances might be responsible for influencing openness towards unfamiliar foods: 'Due to my allergies, I am more fearful towards unfamiliar foods'. Future studies should interrogate respondents on this aspect and control for this element to better assess dynamics of neophobia and insect openness.

Knowledge, acceptance and behaviours towards entomophagy and insect farming

At the beginning of the projects (survey A), three closed questions were asked to assess participants' knowledge towards entomophagy. When questioned about whether they had already heard about the practice of eating insects, 87% of the respondents replied yes, which is lower than the 97% average previously assessed for French Canadian adults (Hénault-Ethier et al., 2020). Although 77% of them knew that insects represented a sustainable alternative to conventional meat, only 25% knew that entomophagy is a common practice in cultures representing about a quarter of the world population. No statistical difference was observed between the three participating cohorts (A1, A2 and A3).

As for their experiences and future intentions relating to entomophagy, 27% of male and 18% of female participants mentioned having already eaten insects (Table 3 and

TABLE 2 Representation of neophobia categories (low [L], mild [M], high [H] neophobes [Np]) according to respondents' region of origin.

Region		LNp	MNp	HNp	Total
CanUS	<i>n</i>	61	345	76	482
	%	12.7%	71.6%	15.8%	
Eur	<i>n</i>	5	28	6	39
	%	12.8%	71.8%	15.4%	
LAC	<i>n</i>	6	13	0	19
	%	31.6%	68.4%	0%	
Asia	<i>n</i>	6	40	2	48
	%	12.5%	83.3%	4.2%	
Afr	<i>n</i>	8	32	3	43
	%	18.6%	74.4%	7%	
All	<i>n</i>	86	458	87	631
	%	13.6%	72.6%	13.8%	

Abbreviations: LNp, low neophobes; MNp, mild neophobes; HNp, high neophobes; CanUS, Canada or the United States; Eur, Europe; LAC, Latin America or the Caribbean; Afr, Africa.

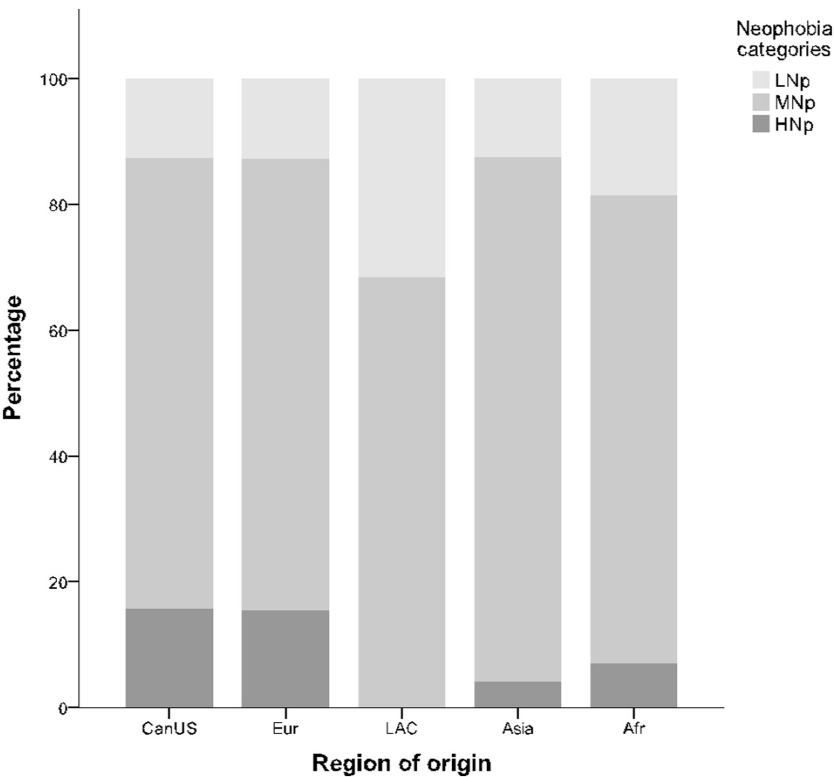


FIGURE 1 Visual representation of neophobia categories (low [L], mild [M], high [H] neophobes [Np]) according to respondents' region of origin.

TABLE 3 Respondents' experience and future intentions relating to entomophagy according to gender (survey A).

Experience and intentions	Female (%)	Male (%)	All (%)
1. Never did; never will	33.3	20.9	29.0
2. Already did; would not repeat	5.0	4.0	4.6
3. Never did; would	48.6	52.4	49.9
4. Already did; would repeat	13.2	22.7	16.5

Figure 2). Half of our respondents had never tried eating insects but declared being willing to do so. Significant differences ($p=0.001$) were observed between males and females, with males being more prone to having already tried eating insects while indicating a willingness to repeat the experience (23% vs. 13%), and females being more likely to have never tried and to never intend trying eating insects (33% vs. 21%). Students' country of origin did not have a significant impact on their past and predicted experience relating to entomophagy.

Students' degree of neophobia had a significant impact ($p<0.001$) on their experience and future intentions relating to insect consumption. Of HNp participants, 65% had never tasted insects and did not intend to do so, whereas only 9% of LNp identified themselves as being in this category (Table 4 and Figure 3). Similarly, 33% of LNp had already tried edible insects and would repeat the experience, compared with <6% of HNp.

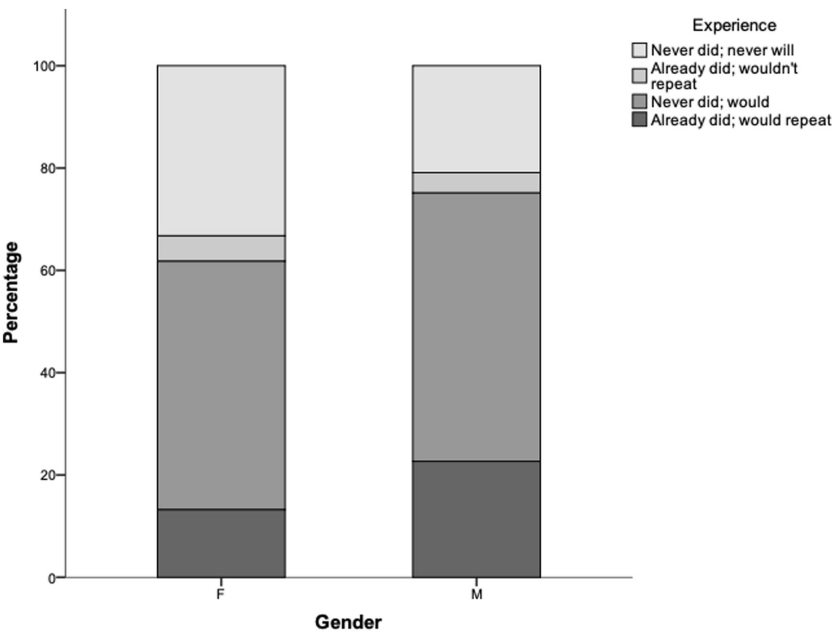


FIGURE 2 Visual representation of respondents' experience and future intentions relating to entomophagy according to gender (survey A).

TABLE 4 Respondents' experience and future intentions relating to entomophagy, according to their neophobia category (survey A).

Experience and intentions	LNp (n)	LNp (%)	MNp (n)	MNp (%)	HNp (n)	HNp (%)
1. Never did; never will	8	8.8	127	26.5	59	64.8
2. Already did; would not repeat	3	3.3	23	4.8	4	4.4
3. Never did; would	50	54.9	257	53.5	23	25.3
4. Already did; would repeat	30	33.0	73	15.2	5	5.5

When initially questioned about the motives why they would be willing to consume edible insects, the most popular reasons (corresponding to answers 4 and 5 on the Likert scale) were respectively 'curiosity' (62%) and 'ecological concerns' (62%), followed by 'health' (56%) and 'personal challenge' (56%), 'ethical concerns' (54%) and 'to be noticed' (8%). The average score given to each reason is shown in Table 5. These motives were also observed in respondents' qualitative comments, although ethical concerns sometimes appeared as a preoccupation preventing insect consumption:

I have a great phobia for insects. If I weren't afraid of them, I would be willing to eat them for my own health and for the environment. Roxane, second cohort.

I hope we can compare insects to conventional meat in class on several levels, such as ecological, nutritional, gastronomic, and economic benefits. Justin, third cohort.

I am a vegetarian and plan on becoming vegan, but if it has a positive impact on my health, I would be willing to give it a try. However, for me, killing an insect, a fish, a bird, or any other animal is all the same, as they are living beings. Catherine, first cohort.

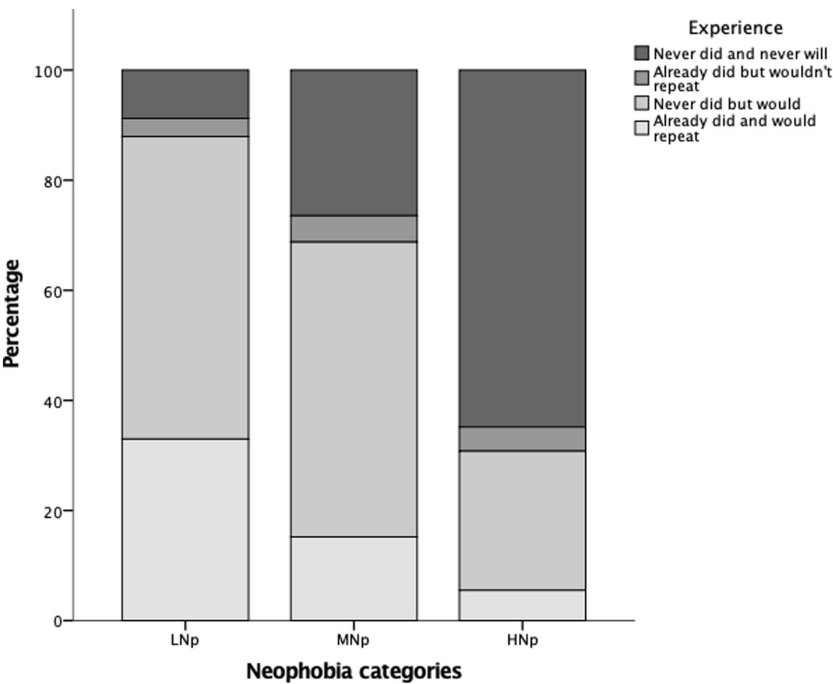


FIGURE 3 Visual representation of neophobia categories according to respondents' experience and future intentions relating to entomophagy.

TABLE 5 Relative importance of specified motives to consume edible insects (survey A).

Factor	Gender	Mean	SD	Female/male <i>p</i> *
Curiosity	Female	3.41	1.323	0.043*
	Male	3.63	1.354	
	All	3.49	1.337	
Health	Female	3.47	1.185	0.134
	Male	3.32	1.252	
	All	3.42	1.210	
Ecological	Female	3.70	1.233	0.031*
	Male	3.47	1.333	
	All	3.62	1.272	
Ethical	Female	3.33	1.285	0.000*
	Male	2.78	1.376	
	All	3.14	1.342	
Personal challenge	Female	3.04	1.425	0.925
	Male	3.05	1.468	
	All	3.04	1.439	
To be noticed	Female	1.58	0.971	0.020*
	Male	1.79	1.106	
	All	1.65	1.024	

*Robust test of equality of means (Welch correction) performed when ANOVA *p* > 0.05.

Are insects ethically a good option for vegans? Luc-Olivier, third cohort.

I find that it would not make sense to eat (insects) as I am vegan, and I already excluded other sensible living creatures from my diet. However, I would be curious to learn more about insect farming and its ecological impact. Sara, first cohort.

The perceived ethicality of edible insects for vegetarians and vegans was not specifically investigated as part of the project, as few participants mentioned adopting such diets. It is an issue that remains to be investigated in future work, in order to better understand young meat avoiders' potential motivations for engaging with entomophagy or avoiding doing so.

As shown in Table 5, ecological ($p=0.031$) and ethical concerns ($p>0.001$) (e.g. practical reasons) were significantly more popular amongst female participants, whereas males were more tempted by personal or social factors, such as 'curiosity' ($p=0.043$) and 'to be noticed' ($p=0.02$). Only two of these factors ('health' and 'personal challenge') were found to vary insufficiently to show a statistical difference according to participants' gender ($p>0.05$).

When participants were asked four questions in survey A regarding how they felt about the idea of having an insect farm in class, 18% were moderately or very scared (with 37% undecided), 63% were moderately or very curious (with 14% undecided), 48% thought it was a good idea (with 14% undecided) and 19% thought insect farms should not belong in schools (with 30% undecided) (Figure 4). Respondents' qualitative comments relating to their anticipation towards the insect farming project were also largely positive:

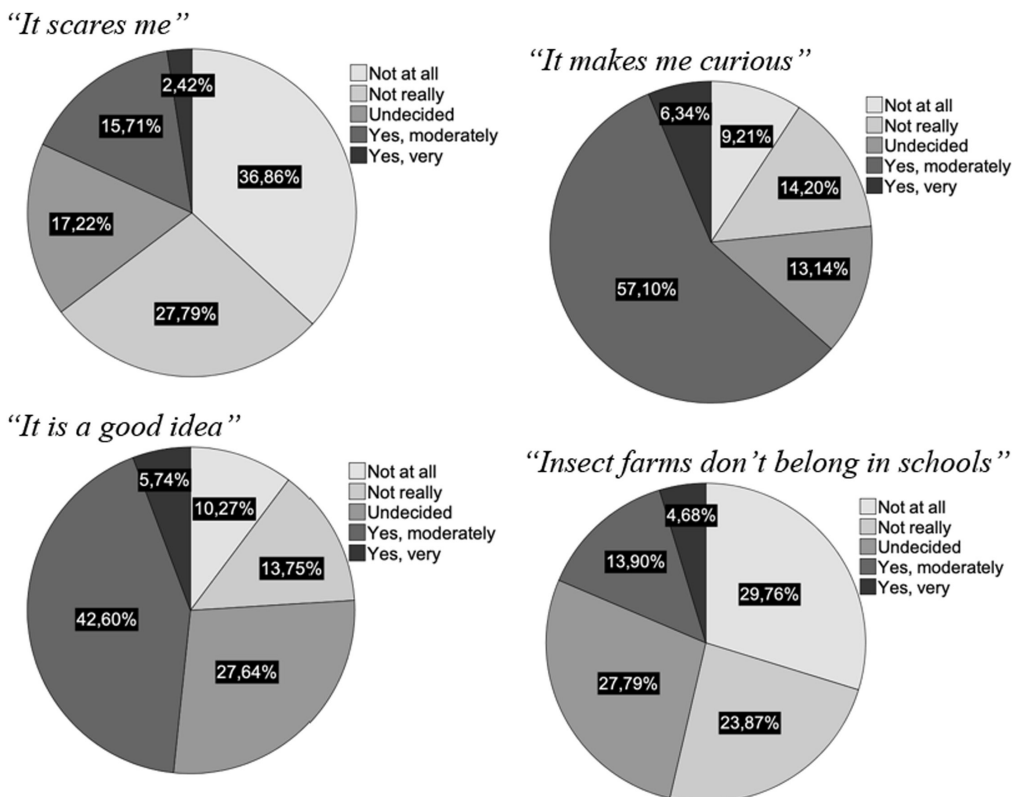


FIGURE 4 Respondents' perception of having an insect farm in class (survey A).

I've already farmed mealworms before. I found it not only educative but super fun (mine was named Arthur). I would really like to have an insect farm in my classroom. Léa, first cohort.

I already consume cricket flour. I find GREAT the idea of having an insect farm in class. Thomas, third cohort.

Evolution of acceptance and behaviours towards entomophagy

Post-project surveys revealed great variations in students' experience and intentions towards entomophagy (as compared with pre-project surveys), with this time no statistically significant variation between female and male participants ($p=0.253$). Over the course of the project (comparing surveys A and B), the proportion of participants that had already tried edible insects and would be willing to do so again rose from 13 to 76% for females, and from 23 to 80% for males; those that had never tried and never intended to try it dropped from 33 to 7% for females, and from 21 to 6% for males (Table 6 and Figure 5). In the pre-project surveys, females were 25% more likely than males to have already tried consuming insects without wanting to repeat it (5 vs. 4%); in the post-project surveys males were 50% more likely than females to find themselves in the same situation (5.4 vs. 3.6%). At the end of the projects, a total of 10% of the female and 11% of the male participants stated that they would not be willing to engage in edible insect consumption in the future, compared with respectively 38 and 25% prior to the projects.

The motives that explain such a change in students' attitudes and behaviours seem to relate to many factors. As also highlighted in some of their post-project open statements, the motivational factors that have gained significant importance ($p<0.001$) over the course of the project were respectively health and ecological concerns (for participants altogether). Ethical concerns ($p<0.001$) and curiosity ($p=0.003$) factors also gained significant importance for females (Table 7). Males were significantly ($p<0.001$) less inclined to do it as a personal challenge than they did in pre-project surveys, and both genders gave significantly ($p<0.001$) less importance to the motive of being noticed, which was already the less popular one in the pre-project surveys.

Insects are the way out for cutting meat. William, third cohort.

We should talk about (entomophagy) more in order to save the fate of the planet! Venus, third cohort.

TABLE 6 Evolution of respondents' experience and future intentions relating to entomophagy, when questioned after the project.

Experience		Female (%)	Male (%)	All (%)
Never did; never will	Post-project survey	6.6	5.9	6.4
	Variance	-26.7	-15	-22.6
Already did; would not repeat	Post-project survey	3.6	5.4	4.2
	Variance	-1.4	+1.4	-0.4
Never did; would	Post-project survey	13.8	8.9	12.1
	Variance	-34.8	-43.5	-37.8
Already did; would repeat	Post-project survey	76	79.7	77.2
	Variance	+62.8	+57	+60.7

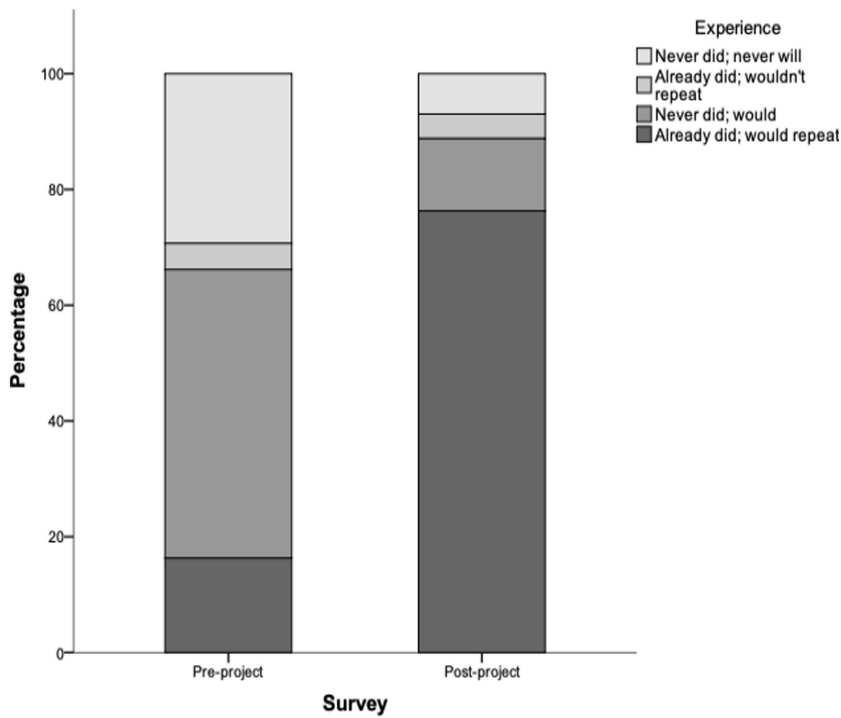


FIGURE 5 Visual representation of the evolution of respondents' experience and future intentions relating to entomophagy.

TABLE 7 Motivational factors to engage with entomophagy in surveys A and B, according to gender.

Motive	Gender	Survey A Mean	Survey B Mean	Survey B SD	Survey B Variance (%)	Survey B Female/ male p^*	Survey A/B p^*
Curiosity	F	3.41	3.7	1.504	5.8		0.003*
	M	3.63	3.58	1.607	-1		0.743
	All	3.49	3.66	1.540	3.4	0.393	0.033*
Health	F	3.47	4.01	1.215	10.8		0.000*
	M	3.32	3.78	1.437	9.2		0.001*
	All	3.42	3.93	1.298	10.2	0.055	0.000*
Ecological	F	3.70	4.17	1.221	9.4		0.000*
	M	3.47	3.87	1.487	8		0.003*
	All	3.62	4.07	1.324	9	0.014*	0.000*
Ethical	F	3.33	3.76	1.435	8.6		0.000*
	M	2.78	2.83	1.790	1		0.751
	All	3.14	3.44	1.625	6	0.000*	0.000*
Personal challenge	F	3.04	3.07	1.799	0.6		0.767
	M	3.05	2.41	1.938	-12.8		0.000*
	All	3.04	2.84	1.873	-4	0.000*	0.039*
To be noticed	F	1.58	0.86	1.396	-14.4		0.000*
	M	1.79	1.06	1.589	-14.6		0.000*
	All	1.65	0.93	1.466	-14.4	0.136	0.000*

*Robust test of equality of means (Welch correction) performed when p ANOVA > 0.05.

The population should be better informed so that they open to the idea of eating insects. Especially if they aren't aware of all their benefits. Louis, second cohort.

When students were asked about their appreciation of the project and their future intentions relating to insect farming, 64% mentioned they had been either moderately or very interested to learn more in class about insects and their farming (with 19% undecided) and 13% mentioned being open to the idea of raising insects at home (with 16% undecided) (Figure 6). Open comments also highlighted their high enjoyment after partaking in the projects:

It was very interesting to taste insects. Otherwise, I don't think I would have purchased insects just to try them. Rosalie, first cohort.

I enjoyed eating (insects) and found out that it wasn't at all gross or scary. Emma, second cohort.

It was a very interesting and innovative project! I hope to consume insects more regularly when they become more widely available. Magalie, first cohort.

I think that education about entomophagy should be compulsory in all schools as it is a great way to start saving our planet. Jeanne, second cohort.

(This project) really changed my vision of insects! I strongly encourage talking more about it in schools! Anne-Laurence, first cohort.

We should talk more about (insects) in class and get the students from all levels involved in this project in order to raise awareness at all ages. Jessica, third cohort.

Beliefs regarding the future of entomophagy

When asked a series of questions aiming to assess their beliefs regarding the future of entomophagy (surveys B), 96% of participants thought that insects could represent an advantageous nutritional choice over conventional meat (closed question), 83% that edible insects should be available in grocery stores, 75% that humans should eat more insects, 71% that

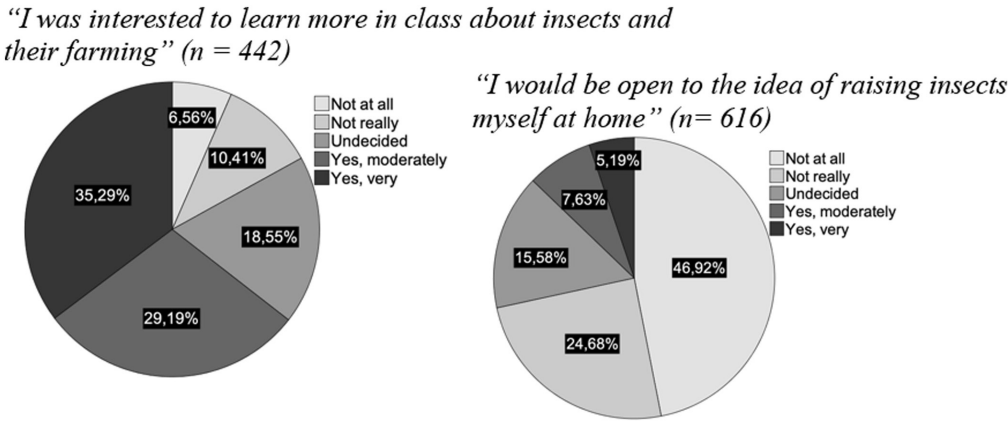


FIGURE 6 Respondents' appreciation of the project and future intentions relating to insect farming (survey B).

more and more people will consume insects in North America and 88% that we should feed more animals using insects (Table 8). The open statements they provided highlight their optimistic view about the future of entomophagy:

I believe that over time, society will get used to eating insects and hardly anyone will be disgusted by them. Veronica, second cohort.

I think more work should be done on overcoming people's mental block when they face bugs and find them repulsive, so that in the long run they no longer feel disgusted. Alissia, second cohort.

I think it is good to raise our awareness now as I believe (entomophagy) will gain in scale and importance over the years. It should be considered as an innovative solution to fight climate change! Aurélie, third cohort.

I really enjoyed this experience and I hope that we will find more insects in grocery stores to (...) consume them daily. More cookbooks should include insects (...) Sofia, third cohort.

It would be interesting to integrate insects into our food culture. Billie, first cohort.

Many people are afraid to try insects and to incorporate them into their diet because it is unusual for them. Even I, who claim to be open to the idea, am a little nervous about it. Creating advertisements, trial opportunities, and making them (more widely) available in grocery stores would greatly help to make people more comfortable and open-minded towards this practice. Carlos, first cohort.

Preference for insect-based products

In survey A, participants were asked about their preferences regarding the form(s) in which they would be willing to consume edible insects (whole, crushed and/or powdered). Globally, participants declared preferring powdered and crushed insects, with powder being the most popular form. A much greater proportion of LNp participants selected crushed and whole insects as compared with MNp, themselves being more inclined to select these same insect forms as compared with HNp (Table 9). In contrast, powdered insects showed the reverse trend: they were more popular amongst MNp participants, and this preference was further enhanced amongst HNp. Such a difference relating to participants' preferences for insect products, according to

TABLE 8 Statements aiming to assess participants' beliefs regarding the future of entomophagy.

	Not at all (%)	Not really (%)	Undecided (%)	Moderately (%)	Very (%)
I believe humans should eat more insects	4.55	4.55	16.2	29.1	45.6
I believe edible insects should be available at the grocery store	2.9	2.4	11.5	24.4	56.8
I believe more and more people will consume insects in North America	3.2	5.2	20.8	38.5	32.3
I believe we should feed more animals using insects	1.3	1.9	8.3	17.9	70.6

the neophobia category in which they were grouped, was found to be significant for whole ($p=0.003$) and crushed ($p<0.001$) forms, but not for the powdered one ($p=0.455$).

In survey B, participants were questioned once again about their preferences for insect-based products. Although in both surveys male and female participants declared a preference for powdered insects, females were found to have a significantly greater preference for them than males ($p<0.001$), themselves being much more willing to consume whole insects ($p<0.001$). In post-project surveys, a sharp decrease in the number of respondents choosing the answer 'none', and a sharp increase in those choosing the answer 'powdered', were observed amongst both genders. Their preference for 'whole' and 'crushed' insect forms remained relatively stable in both surveys (Table 10 and Figure 7).

In surveys A and B (after tasting activities were held), students were asked if they would rather tend to associate edible insects with sweet than savoury recipe formulations. The average responses went from an average of 2.78 (slightly disagree) in survey A to 3.21 (slightly agree) in survey B. No significant difference was observed according to participants' gender ($p=0.252$).

In both surveys, students were also asked if they would rather consume crickets than mealworms, and compared two different insect forms (whole and powdered). At the beginning of the projects (survey A), differences were not significant, showing a slight preference for crickets, most especially in the powdered form. However, at the end of the projects (survey B), a significant difference can be observed ($p<0.001$) in the responses provided by both initial student cohorts (1 and 2, having engaged in cricket farming) compared with that of the last cohort (3, having farmed mealworms), but only as regarding their preferences for whole crickets (they did not agree anymore with having such a preference), and not for the powdered ones (Table 11 and Figure 8).

The qualitative comments provided by participants at the end of the project are highly reflective of their above-mentioned preference for insect-based food products:

TABLE 9 Preferred form(s) for edible insects according to participants' neophobia categorisation (survey A, possibility to select many responses).

Form	LNp (%)	MNp (%)	HNp (%)	All (%)
Whole	37.4	23.3	16.5	24.3
Crushed	38.5	32.3	13.2	30.5
Powdered	61.5	65.4	70.3	65.6

TABLE 10 Preferred form(s) for eating edible insects selected in surveys A and B, according to participants' gender.

Form	Survey	Female (%)	Male (%)	All (%)	Female/male p^*
Whole	A	17	39	24	<0.001*
	B	17	37	23	<0.001*
Crushed	A	30	34	31	0.36
	B	29	40	33	0.01*
Powdered	A	72	57	66	<0.001*
	B	94	82	90	<0.001*
None	A	18	17	17	0.762
	B	4	5	4	0.717

*Pearson's χ^2 .

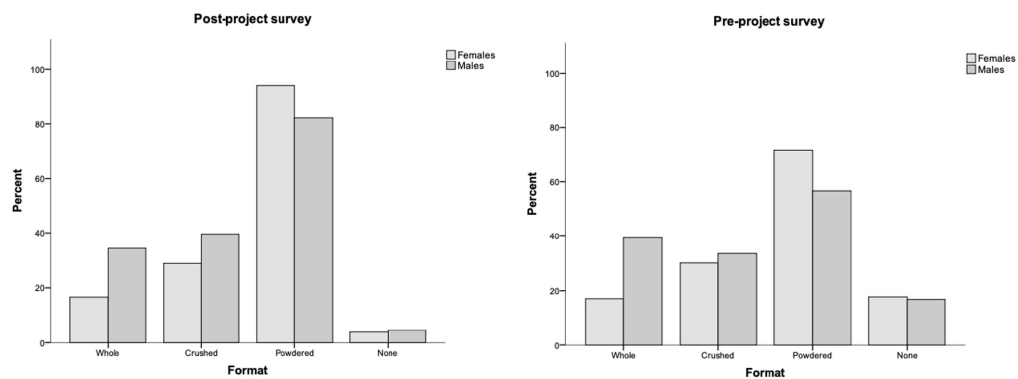


FIGURE 7 Visual representation of the preferred form(s) for eating edible insects selected in surveys A and B, according to participants' gender.

TABLE 11 Respondents' preference for crickets (1–5 scale) divided by cohort (1–3) and survey (A and B).

Survey	<i>n</i>	Whole mean	Whole SD	Powdered mean	Powdered SD
A1	216	3.26	1.403	3.21	1.253
A2	209	3.09	1.468	3.24	1.282
A3	237	2.98	1.445	3.35	1.249
All A	662	3.10	1.442	3.27	1.260
B1	223	3.20	1.305	3.13	1.133
B2	172	3.08	1.346	3.13	1.270
B3	221	2.48	1.360	2.98	1.150
All B	616	2.91	1.374	3.08	1.179

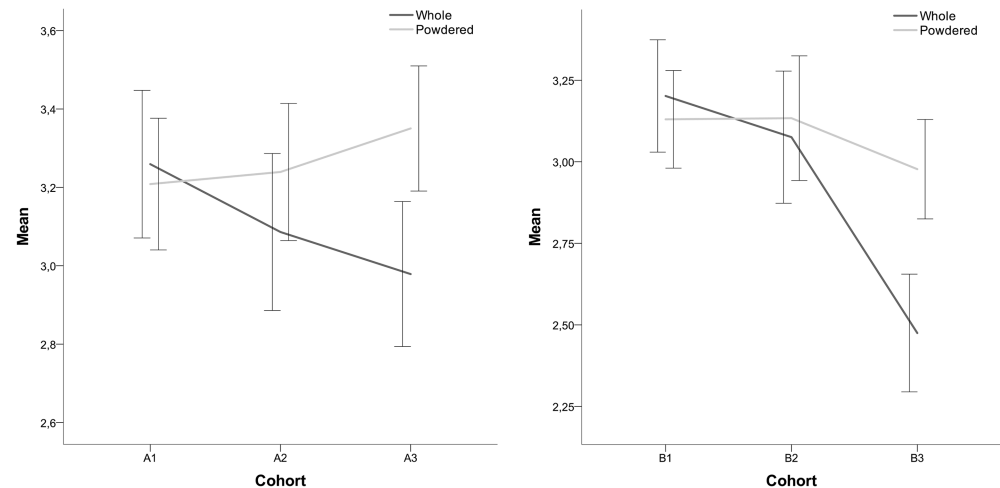


FIGURE 8 Visual representation of respondents' preference for crickets (1–5 scale) divided by cohort (1–3) and survey (A and B).

I think the only reason why I would refuse to eat bugs is because their appearance really turns me off. I might be more inclined to eat them if they were presented in a way that you couldn't distinguish them. Julia, third cohort.

I would appreciate another tasting opportunity, not with whole (insects) but in the form of flour. Felipe, third cohort.

I like barbecue-flavoured insects. Zack, second cohort.

I think that we should focus on the nutritional aspect of mealworms rather than their taste, and that they should be served in recipes avoiding sugars and animal fats (...). Felix, third cohort.

I prefer the taste of crickets and find them less disgusting as compared to other insects. I would rather eat them powdered, and I prefer when they are served in combination with other foodstuffs. Mathieu, third cohort.

Student's influence on their peers

The comparison of responses from the three student cohorts in survey A reveals a significant difference ($p=0.03$) regarding participants' experience and future intentions relating to insect consumption. A multiple comparison test reveals that this difference is not present amongst both starting cohorts (A1 and A2), but only when these are being compared with the last participating cohort ($p=0.001$ when comparing A1 with A3, and $p<0.001$ when comparing A2 with A3). Amongst the last cohort, fewer participants declared never having tried and never intending to try eating edible insects, with a greater proportion of them being rather inclined to try it (Table 12). Some of the participating students' open quotes also highlighted the potential role of adolescents for promoting entomophagy, namely amongst their family members:

I tasted (insects) ... not that bad finally! I even got my family to eat some without them knowing! Hahaha.

My dad is launching his own cricket powder project.

I'm sure that (entomophagy) would become a growing habit in Quebec, if only households were made aware of all its benefits.

Keep doing such conferences in schools because we are the new generation and changes will come with us.

TABLE 12 Participants' experience and future intentions with entomophagy amongst cohorts (survey A).

	<i>n</i>	Did not/ would not	Did/would not	Did not/ would	Did/would	Compared with	Comparison <i>p</i>
A1	216	34%	5%	48%	13%	A2 A3	0.988 0.001*
A2	209	34.5%	5%	48%	12.5%	A1 A3	0.988 0.000*
A3	237	20.5%	4%	53%	22.5%	A1 A2	0.001* 0.000*
All	662	29%	4.5%	50%	16.5%		

DISCUSSION

Participants' initial knowledge, attitudes and behaviours

The fact that no important correlation has been observed regarding participants' gender and their degree of neophobia is consistent with the study of Meiselman et al. (1998), which did not show noticeable gender differences when comparing young people's eating behaviours. Although no study has been found in the literature aiming to assess the degree of food neophobia experienced by young Canadians, a survey involving California university-level students ($n=554$) identified an average FNS score of 29.8/70 (Olabi et al., 2009). Another survey, this time involving Australian students divided into two separate high-schools—one situated in an urban area and the other located more remotely—revealed FNS scores ranging from 29.32/70 for urban participants ($n=696$) to 34.68 for rural ones ($n=243$) (Flight et al., 2003).

The FNS results collected in the present survey (equivalent to 32/70) appear quite coherent with these observations. The vast majority (72%) of participating students were born in Canada, and the school they attended is in a suburban area, the surrounding environment of which is characterised by the presence of very few restaurants promoting international cuisines. A much higher proportion of these Canadian-born students were marked as highly neophobic (15.8%), as compared with students originating from other countries that are known to contain entomophagous communities (Afr 7%, Asia 4.2%, and LAC 0%). This observation supports the finding that cultural identity is likely to influence the degree of food neophobia one can experience (Flight et al., 2003). However, it is important to cautiously acknowledge that students' country of origin does not allow one to draw a straight parallel with their actual cultural background or ethnicity.

At the beginning of the project (surveys A), the vast majority (87%) of participants mentioned knowing about the practice of entomophagy (it appears quite likely that some of them had already heard about the upcoming projects), but only a quarter were aware of how widespread this practice was. The fact that most of them (79%) had never tasted insects before seems largely due to a lack of trial opportunities, as 63% of those who had never tried eating insects before mentioned being willing to do so. Of all the students partaking in the present project, only 29% initially mentioned being totally closed to the idea of eating insects. Most of the participants ranking as highly neophobic were found in this category, thus supporting previous evidence that neophobia represents a strong predictor of consumers' (un)willingness to eat insects (Hartmann et al., 2015; Verbeke, 2015).

Moreover, male participants were more likely than female ones to have eaten insects already (27 vs. 18%), and amongst these experienced participants, a higher proportion of males also indicated a willingness to engage once again with entomophagy (85 vs. 73%). If a greater acceptance of males towards entomophagy had already been identified in the scientific literature in many cultures (e.g. Florença et al., 2021; Ruby et al., 2015; Tuccillo et al., 2020; Videbæk & Grunert, 2020), it is interesting to observe that the great majority of our participants who mentioned having already tasted insects before (both male and female) were satisfied enough by their experience to be willing to repeat it once again.

As for their main motivations to consume edible insects (in survey A), all the suggested factors apart from 'to be noticed' were considered at least somewhat important by most of our surveyed respondents. Ecological and ethical concerns (e.g. practical reasons) were significantly more popular amongst female respondents, whereas males were more tempted than females both by curiosity and to be noticed by their peers (e.g. personal or social reasons). Beardsworth et al. (2002) found that women generally tended to be significantly more sensitive, caring and aware of ethical, ecological, nutritional and body image issues when it came to eating—leading them to show a greater inclination for trying novel food items. This

latter observation contrasts more recent studies which underlined men's greater exploratory food sense (e.g. Sogari et al., 2019; Wilkinson et al., 2018)—although such a gender asymmetry as pertaining to neophilia appears less obvious amongst teenagers (Rossbach et al., 2016). Other studies have also suggested a heightened concern by women for the environment (e.g. Niva et al., 2014; Sanchez-Sabate & Sabaté, 2019) and animal welfare (e.g. Blanc et al., 2020; Dowsett et al., 2018), and the impacts of meat consumption, but their focus was on adult rather than adolescent subjects. Regarding motivations relating to health and personal challenge, we observed a similar importance granted by both genders.

Most participants initially declared having a much greater preference for powdered insects, followed respectively by crushed and whole ones. The LNp participants were much more willing to consume visible insects (i.e. either whole or crushed) as compared with MNp, who themselves were much more willing to do so as compared with HNp. Powdered insects, in contrast, were more popular amongst MNp and even more amongst HNp. Male participants were also more willing to consume visible insects, whereas females were more willing to consume powdered insects. These observations are partly in line with a previous study describing potential Western consumers of insect-based foods as highly neophilic (i.e. craving novelty) young males (Verbeke, 2015). However, the present study could only validate such characteristics as regards to insects in a visible form, not in the powdered one—which was the most preferred form for consuming insects amongst the participating students. In the powdered form, no asymmetry in attitudes relating to gender or neophobia was observed. Concealing edible insects' visual properties through processing might represent a successful avenue to bypass reluctant behaviours (Tan et al., 2017), thus leading to the enhanced possibility of marketing insect products to an audience that expands beyond the highly adventurous eater.

Concerning taste associations within insect-based foods, both genders were not quite sure whether they would prefer eating insects in sweet or savoury recipes. Participants were initially slightly less likely to associate them with a sweet recipe, but this position seems to have shifted by the end of the project—possibly after having been presented with various types of insect foods when engaging in tasting activities. All three cohorts ended up with a preference for crickets in the powdered form. As for whole insects, participants developed a preference for the type of insects that they had been familiarised with in class while engaging in farming activities (i.e. crickets or mealworms). This observation strengthens the hypothesis that exposure and familiarisation can play a great role in promoting consumers' acceptance towards insect-based foods (Tan et al., 2015). However, all these preferences were not assessed by systematically tasting insect products, meaning that many participants have self-reported their answers based only on their beliefs at the time of completing the survey and/or on inferred organoleptic features.

Evolution of attitudes and behaviours

Most participants declared having tasted insects for the first time in their lives over the course of the project—either on their own or during insect tasting activities that were organised at the end of each project units. Over three-quarters of the most refractory students (i.e. who had initially no experience with entomophagy and did not intend to engage with insect tasting, as mentioned in survey A) actually ended up tasting insects during these 3 month periods (as indicated in survey B). Educational presentations and *bug banquets* were previously found to have only a subtle effect on altering Canadian students' attitudes towards entomophagy (Looy & Wood, 2006). The integrative praxis at the core of the present project was effective in generating behavioural change. It combined workshop, teaching, and farm to school activities to increase adolescents' motivational drivers while developing their sense of ability.

The motivations explaining this change in participants' behaviours towards entomophagy appear largely attributed to health, ecological and ethical concerns. At the end of the project, participants who were open to entomophagy appeared much less driven than they were initially by individualistic motivations relating to 'personal challenge' (males) and 'to be noticed' (both genders). Besides decreasing reluctance towards edible insects and altering social norms prevailing amongst the classroom, the project thus seems to have successfully aroused participants' food awareness—effectively communicating and facilitating the understanding of the wide-ranging benefits associated with entomophagy.

Although female participants were initially found to be more reluctant than males towards engaging in insect consumption, both genders ended up with similar experiences and intentions relating to entomophagy. As compared with male participants, a larger proportion of females consumed edible insects for the first time over the course of the project. Besides successfully contributing to overcoming reluctant behaviours towards entomophagy, the project was largely appreciated by participating students. After mentioning that farming insects in class triggered their curiosity rather than scared them, most (64%) participants also indicated having been interested to learn more in class about insects and their farming methods—some (13%) even declaring being open to the idea of raising insects at home.

Acknowledging edible insects' relative advantage and ensuring their compatibility with one's values, practices and habits are fundamental steps leading to their successful adoption as food innovations (Rogers, 2003). The present project seems to have allowed participants to overcome these initial steps, as demonstrated by the fact that, following its completion, the great majority of participants were convinced that insects might represent an advantageous nutritional choice over conventional meat. Most of them also declared that they believed that edible insects should be made more widely available, and that they should also be more commonly consumed. Most participating students were even confident enough to predict that the practice of entomophagy is going to gain extensive popularity in North America. An even greater proportion of participants believed that more animals should be fed using insects.

The third cohort partaking in the project indicated a greater initial experience with insect consumption and a less pronounced reluctance towards entomophagy, as compared with previous cohorts. Hence, within a single year, entomophagy seems to have been significantly normalised amongst students of the science and technology programme. This observation demonstrates the rapid and significant impact that peer influence can play at a young age, especially when adolescents acquire valuable knowledge about issues that resonate with their personal values and for which they feel empowered. With adolescents tending to widely adhere to social norms prevailing in their social circle, the group-based actions at the core of this project helped alter collective behaviours in the classroom. Besides significantly altering participants' attitudes and behaviours towards entomophagy, the project is likely to have also aroused the curiosity of other students who were not directly involved in it, hence widening the scope of its impact.

Limitations of the study

This project addressed Lewin's (1943) two initial phases of group dynamics aiming to achieve individual change, namely reflection leading to the abandonment of initial behaviours and experimentation with new practices. However, it does not allow verification of whether the third phase was reached: the integration of new habits. Only willingness to eat insect products was assessed, relying on self-reported surveys. Further behavioural studies should thus focus on attempting to validate whether participants end up engaging in insect eating on a regular basis. Further investigations could also involve tastings performed within focus

groups, allowing for a more in-depth understanding of adolescents' preferences for insect products. Another main limitation of this study is that participating students were all enrolled in a science and technology programme. Hence, their heightened interest in environmental issues might not be representative of the average adolescent.

CONCLUSION

The present study reveals interesting insights that can be leveraged to improve the efficiency of future communication and marketing campaigns designed to promote the adoption of edible insect products amongst adolescents—whose malleable food preferences underline their potential to become lead users of discontinuous food innovations. Over the course of these 3 month projects, edible insect consumption became significantly normalised amongst participants. Enhanced exposure and familiarisation seem to have played a great role in promoting their acceptance towards insect-based foods. In the light of these findings, the speed and impact of adolescents' peer influence should be leveraged in promotional efforts aiming to accelerate the adoption of edible insects amongst Westerners. Integrating theoretical and applied components in school curricula through the implementation of educational and participative insect farms can help overcome food neophobia while promoting the adoption of early sustainable food habits. Generating discussions towards agri-food systematic issues—such as social and environmental sustainability, human health and food security—leads to a greater food awareness. Understanding the wide-reaching impacts of our everyday food decisions helps forge a desire to trigger change amongst the food system and translates into a greater respect towards traditional and culturally diverse culinary habits, as well as an enhanced appeal for natural, ethical and local products.

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CONFLICT OF INTEREST STATEMENT

None.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS APPROVAL

This research was conducted in compliance with the ethical guidelines of Concordia University for research involving human subjects (certificate number 3007979).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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