



Group cooking sessions with crickets: Effects on high school students' acceptance of entomophagy

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29 Abstract

30 Although some debate and criticism persist, many studies highlight the high production
31 efficiency and lower environmental impact of edible insects. They have gained
32 international attention as a promising alternative protein source. However, in many
33 modern cultures, food insects are still viewed with skepticism. This study investigated
34 whether hands-on educational activities, including cooking and tasting cricket-based
35 dishes, could improve Japanese high school students' acceptance of edible insects.
36 Conducted at a high school, the research involved two main groups: (1) students in the
37 food science department who developed and prepared cricket-based recipes, and (2)
38 general students who tasted these dishes during a quasi-school lunch program. Surveys
39 and interviews were administered before and after a series of lectures and cooking
40 sessions to assess changes in attitudes toward entomophagy. Results showed that while
41 many students recognized the environmental and nutritional merits of insects, a
42 significant proportion remained reluctant to eat them in recognizable forms. Masking
43 crickets' appearance and flavor temporarily reduced aversion, yet did not consistently
44 extend to broader acceptance of other insects. By contrast, students who actively engaged
45 in cooking were more open-minded, indicating that direct involvement may help
46 incorporate entomophagy. These findings inform future educational strategies, suggesting
47 that integrating both practical cooking experience and broader cultural-historical lessons
48 may be crucial for re-incorporating entomophagy in areas where entomophagy once
49 existed.

50

51 Introduction

52 Ensuring a sustainable and sufficient food supply for a growing global
53 population remains a critical challenge (Vanbergen *et al.*, 2020; Kremen and Merenlender,
54 2018). Many researchers argue that edible insects, including crickets, offer a high
55 production efficiency and relatively low environmental impact, potentially contributing
56 to future food security (Onwezen *et al.*, 2019; van Huis *et al.*, 2013; Reverberi, 2020).
57 However, it remains uncertain whether they can fully address global food crises, and
58 skepticism persists regarding their overall feasibility as a mainstream protein source
59 (Lundy and Parrella, 2015; Smetana *et al.*, 2023; Biteau *et al.*, 2025). Historically, insects
60 have been a key food resource across various cultures (Pager, 1976; Backwell and
61 d'Errico, 2001; Rothman *et al.*, 2014), including Japan—where certain regions maintain

entomophagy traditions (Miyake, 1919; Nonaka, 2005; 2008). Yet, modern societies that have shifted away from these practices often view insects as unfamiliar or off-putting (Yen, 2009; Saga *et al.*, 2022).

Recently, environmental education programs have highlighted the ecological benefits of insects as a sustainable food source (Caparros Megido *et al.*, 2014; Sogari *et al.*, 2017; Fischer and Steenbekkers, 2018; Rumpold and van Huis, 2021; Chow *et al.*, 2021; Erhard *et al.*, 2023; Maya *et al.*, 2023). However, many such programs do not have practical cooking sessions that could address psychological barriers surrounding insect consumption. While some studies (e.g., Chow *et al.*, 2021) included insect-cooking components, they reported limited shifts in attitudes. Conversely, research suggests direct tasting can significantly reduce negative perceptions and increase willingness to eat insects (Caparros Megido *et al.*, 2014; Hartmann and Siegrist, 2016; Mancini *et al.*, 2019). Against this backdrop, the Japanese government has promoted cricket consumption to address potential food crises (Ministry of the Environment, 2017). In regions such as Japan, entomophagy was once widespread but is no longer part of mainstream culture (Payne, 2015). There is a lack of knowledge regarding how introducing insects as sustainable food resources and providing hands-on cooking experiences affect young people's acceptance of entomophagy.

Although crickets are praised for their low environmental impact and high production efficiency (Maya *et al.*, 2023; but see Smetana *et al.*, 2023; Biteau *et al.*, 2025), it remains uncertain whether acceptance of a single insect species can foster broader entomophagy practices. Repeated exposure and positive sensory experiences may be necessary for lasting dietary changes (Szczepanski *et al.*, 2022). If cricket dishes prove both palatable and eco-friendly, a more accepting stance toward insects as food could emerge (Barton *et al.*, 2020). If not, more comprehensive approaches might be required to overcome cultural barriers. By examining this novel high school program, our study provides practical insights for educators, policymakers, and the food industry seeking to integrate entomophagy into daily diets—in Japan and beyond. This study examined two groups at the high school: (1) food science students who developed and prepared the cricket-based dishes, and (2) general students from various departments who attended a lunch featuring cricket menu options.

Materials and Methods

95 *Study Site*

96 This study was conducted at a high school to investigate how educational
97 lectures and hands-on tasting activities influence students' attitudes toward entomophagy.
98 In these sessions, insect-based foods were prepared to minimize the insects' visible
99 features, taste, and smell, thereby exploring how different educational focuses and
100 presentation methods might affect acceptance.

101 At the high school, located in western Japan and known for its culinary program
102 within the food science department, students learn cooking in group practice sessions.
103 Although this region of Japan has historical entomophagy traditions (Miyake, 1919;
104 Nonaka, 2008), the formal curriculum does not include traditional insect foods and its
105 cultural aspects. To highlight environmental sustainability, the school introduced cricket-
106 based dishes (e.g., pumpkin croquettes and sweet potato fries with cricket extract) into a
107 quasi-school lunch program. During lunchtime, students, teachers, and staff could freely
108 choose whether to purchase these dishes, offering a practical test of acceptance.

109 We interviewed the food science students to explore how hands-on cooking
110 influenced their perceptions of entomophagy, while we surveyed the broader student body
111 to assess shifts in attitudes before and after tasting. Our particular focus was whether
112 introducing crickets could broaden acceptance to other insects traditionally consumed in
113 Japan, such as wasp larvae, pupae, and locusts.

114
115 *Lecture and Tasting Sessions*

116 1. Lecture and Cricket Cookies

117 In June 2022, representatives from a company that produces edible crickets
118 delivered a lecture to all students at the school (336 students in total). They explained the
119 connections between edible insects and several environmental problems, including the
120 “protein crisis,” “food waste,” and “global warming.” At the end of the lecture, each
121 student was offered a cricket cookie.

122
123 2. Cooking Class (Pumpkin Croquettes with Cricket Powder)

124 In November 2022, students in the food science department prepared pumpkin
125 croquettes (a popular Japanese dish) that contained cricket powder (5% of the total
126 ingredients), which were served as part of the regular lunch menu.

128 3. Cooking Class (Sweet Potato Fries with Cricket Extract)

129 In February 2023, as part of a group cooking class, second-year students in the
130 food science department prepared sweet potato fries flavored with cricket extract, served
131 alongside other lunch menu items (Figure 1). This dish is similar to a popular Japanese
132 recipe that typically includes soy sauce, but here the soy sauce was replaced entirely by
133 an extract made from two-spotted crickets (*Gryllus bimaculatus*) and salt. In total, the
134 class used 5 kg of sweet potatoes, 100 g of sugar, 200 g of mirin, and 100 g of cricket
135 extract. Eighty-one students and twenty-three teachers chose this sweet potato fries dish
136 from the self-serve lunch line.

137

138 *Questionnaires and Interviews*

139 1. Perceptions Following the June 2022 Lecture

140 After the June 2022 lecture, the questionnaire was distributed to 336 students
141 (i.e., the entire student body of the high school) and consisted of five questions with the
142 following response options:

- 143 (1) Understanding of lecture content: binary choice (Yes/No),
- 144 (2) Willingness to try cricket cookies: binary choice (Ate/Did not eat),
- 145 (3) General consideration of eating cricket-based dishes: three-point scale (Want to
146 eat/Can eat/Do not want to eat),
- 147 (4) Belief in crickets' potential to address food crises: binary choice (Useful/Not useful),
- 148 (5) Evaluation of lecture benefit: binary choice (Good/Not good).

149

150 2. Interviews with Cooking Club Students

151 On January 27, 2023, we interviewed five cooking club students who had
152 previously prepared cricket croquettes. They discussed:

- 153 (1) Their impressions of making and tasting the croquettes,
- 154 (2) Their perspectives on why insect consumption has become more relevant, and
- 155 (3) Their thoughts on why some traditional diets include insects.

156

157 3. Survey After the Cricket-Based Group Lunch

158 In February 2023, we surveyed the students and teachers who chose to eat the
159 cricket-based sweet potato fries during the group lunch. The survey gathered
160 information on:

- 161 (1) Their reasons for selecting and consuming the cricket dish,
162 (2) Any changes in their environmental awareness after eating crickets,
163 (3) Their opinions on the taste,
164 (4) Their views on farmed insects versus wild insects,
165 (5) Their attitudes of traditional insect-eating practices, and
166 (6) Why insects may be receiving renewed attention in modern Japan.

167 Survey questions employed various response formats: three-point scales for
168 environmental awareness (Much more aware/Somewhat more aware/No change) and
169 attitudes toward whole crickets (Positive/Neutral/Negative), categorical responses for
170 taste evaluation (Good/Bad/Did not eat), binary responses for willingness to try
171 traditional insects (Yes/No), multiple-choice questions for reasons behind cricket
172 consumption and insect consumption trends, four-category responses for preferences
173 between farmed versus wild insects (Willing to eat both/Will eat farmed but not
174 wild/Will eat wild but not farmed/Unwilling to eat either), and three-category responses
175 for overall change in views (Yes/No/Unsure).

176 Both the June 2022 and February 2023 surveys were administered within the
177 same academic year (April to March), and the January interviews were scheduled in
178 cooperation with the school. This study was approved by the relevant ethics committee
179 at the school.

180

181 *Statistics*

182 We conducted exact binomial tests for key survey items to examine whether
183 response patterns differed significantly from chance expectations (50%). For the June
184 2022 survey, we analyzed three primary outcomes: (1) cricket cookie consumption rate,
185 (2) willingness to eat cricket-based dishes in the future, and (3) belief in crickets' potential
186 to address food crises. For willingness to eat cricket-based dishes, we combined "I want
187 to eat" and "I can eat" responses as positive attitudes and compared them against "I don't
188 want to eat" responses.

189 For the February 2023 survey, we analyzed four primary outcomes: (1) change
190 in environmental awareness after cricket consumption, (2) definitive changes in views
191 after eating insects, (3) acceptance of crickets in whole, visible form, (4) willingness to
192 consume farmed or wild insects, and (5) willingness to try traditional Japanese insects.
193 Statistical significance was set at $p < 0.05$.

For these analyses, response categories were combined as follows: For environmental awareness (Q4), "much more aware" and "somewhat more aware" responses were combined as positive change and compared against "no change." For acceptance of whole crickets (Q9), "positive" and "neutral" responses were combined as acceptance and compared against "negative" responses. For willingness to consume insects (Q10), participants who indicated willingness to eat "only artificially farmed insects," "only wild insects," or both were categorized as showing some acceptance, while those who reported unwillingness to eat either type were categorized as completely resistant. For changes in views on the environment, dietary habits, or insects in general (Q12), only "yes" responses were considered as definitive change, while "no" and "unsure" responses were combined as no clear change, since uncertainty was interpreted as lack of clear impact.

Results

1. Awareness of Cricket-Based Food Consumption After the June 2022 Lecture

We collected responses from 336 students (Table 1). Of these, 76.5% ate the cricket cookies offered during the lecture, while 23.5% chose not to. Regarding future willingness to eat cricket-based dishes, 11.6% answered "I want to eat," 54.8% "I can eat," and 33.6% "I don't want to eat." Additionally, 92.9% agreed that crickets could help solve food crises and food waste problems, whereas 7.1% disagreed. Binomial tests revealed that all three response patterns differed significantly from chance (50%) expectations: cookie consumption ($p < 0.01$, $g = 0.28$), willingness to eat cricket dishes ($p < 0.01$, $g = 0.16$), and belief in crisis-solving potential ($p < 0.01$, $g = 0.43$).

Table 1. Survey results following the edible cricket lecture at the high school

1. Did you understand the lecture content?	
Yes	No
313	23
2. Did you try to cricket-based cookies?	
Yes	No
257	79
3. Do you want to eat cricket-based dishes?	

I want to eat	I can eat	I don't want to eat
39	184	113
4. Do you think crickets can help with the food crisis and food loss problem?		
Yes	No	
312	24	
5. How was the "ethical lecture*" ?		
Good	Not good	
329	7	

*Name of this lecture

218

219 2. Student Feedback on Cooking Cricket-Based Foods

220 Interview Results

221 Five students in the cooking club, who had prepared pumpkin croquettes
 222 containing cricket powder, answered their impressions. They felt the cricket powder
 223 blended well with pumpkin; although the powder had a distinct flavor when tasted alone,
 224 it became almost undetected when mixed into the dish. Their strategy was to minimize
 225 the visual and sensory impact of the cricket content so that students trying insect-based
 226 foods for the first time would feel more comfortable.

227 All five students expressed positive attitudes toward eating insects. Two
 228 initially found the idea off-putting, but changed their minds, another two said they
 229 welcomed insects as new culinary ingredients, and one student—who had already been
 230 open to insect consumption—became even more enthusiastic after learning about their
 231 edibility.

232 When asked why eating insects is growing in importance, all five mentioned
 233 that insects provide a valuable protein source, particularly as global food resources
 234 become more limited. They also noted that some people might turn to insects if other
 235 protein sources become scarce. Regarding the inclusion of insects in certain traditional
 236 diets, three students mentioned historical food shortages, one mentioned cultural
 237 continuity, and one was unsure.

238

239 3. Student feedback after cricket-based group lunch

240 A total of 37 people answered the February 2023 survey, but 5 did not give
 241 consent for their data to be used, leaving 32 valid responses. Among these 32 respondents,

242 25 had eaten both the pumpkin croquettes (November 2022) and the sweet potato fries
243 (February 2023), 6 had not tasted the pumpkin croquettes, and 1 had not tried either dish
244 (see Table 2 for details). This student's answers were excluded from questions on taste
245 and post-meal awareness.

246 Among the 32 respondents, five students reported having developed cricket-
247 based recipes in class, and one in club activities (Q5). These students identified several
248 challenges in recipe development, including determining optimal cricket visibility,
249 ingredient pairing, preparation methods, and working with crickets as the primary protein
250 source (Q6). Due to the anonymous nature of the survey, we cannot determine whether
251 the five students who reported developing cricket-based recipes in this survey were the
252 same individuals who participated in the January interviews or the cooking classes.

253 Nearly all survey respondents (31 out of 32) tasted the cricket-based sweet
254 potato fries served at the group lunch, and all 30 students who gave feedback on taste
255 reported they enjoyed it. Most (93.5%) said they could not detect a cricket flavor. The
256 main reason for consuming the cricket dish was a lack of strong aversion to crickets (71%),
257 followed by curiosity and enjoyment of the taste. However, the appearance of intact
258 insects as food did provoke resistance among 64.5% of participants, whereas 19.4%
259 indicated openness to visible insects, and 16.1% were neutral.

260 Participants were asked why insect consumption has recently gained popularity
261 in Japan. The main reasons were relief of potential food shortages (43.8%) and nutritional
262 benefits (12.5%). Cultural acceptance in certain regions was also noted as a significant
263 factor (31.3%).

264 Statistical analysis revealed mixed patterns of acceptance. After eating cricket-
265 based foods, 84.4% of respondents reported increased environmental awareness (34.4%
266 "much more aware," 50% "somewhat more aware"), which was significantly higher than
267 expected by chance ($p < 0.01$, $g = 0.34$). However, most students did not report definitive
268 changes in their views on environment, dietary habits, or insects, with only 18.8%
269 reporting positive changes, while 18.8% reported no changes and 62.4% were unsure.
270 The proportion of students reporting definitive changes was significantly fewer than
271 expected ($p < 0.01$, $g = 0.31$).

272 Regarding insect consumption preferences, 43.5% indicated they would not eat
273 either farmed or wild insects, 40.8% would eat only farmed insects, and 15.6% would eat
274 both types. No one said they would eat only wild insects. Acceptance of crickets in whole,

275 visible form was significantly lower than chance expectations, with only 18.8% showing
 276 positive attitudes compared to 81.3% neutral or negative ($p < 0.01$, $g = 0.31$). While
 277 general willingness to consume insects was not significantly different from chance
 278 (56.3% vs 43.5%, $p = 0.30$), students showed significantly greater resistance to traditional
 279 Japanese insects, with 70% refusing to try them ($p < 0.05$, $g = 0.06$, Table 2).
 280

Table 2. Results of a questionnaire administered after a group lunch at the high school

1. Year/grade					
1st Year	2nd Year	3rd Year			
19	10	3			
2. Did you try the cricket dishes at the group lunch?					
Ate both this and previous pumpkin croquette	Ate this time but not before	Did not eat either time			
25	6	1			
3. If you answered "yes" in the previous question, what is your reason?					
No particular aversion	Recently became interested/curious	I liked that dish	Everyone else was eating it	It was served at the group lunch	A friend invited me
22	3	3	1	1	1
4. Has trying cricket-based food made you think more about environmental issues?					
Much more aware	Somewhat more aware	No change			
16	11	5			
5. Have you ever developed or prepared a cricket-based menu item at the high school (e.g., in class or a club activity)?					
In class	In a club activity	No			
5	1	26			
6. (For those who answered "yes" in Q5) What was the biggest challenge in creating or testing a cricket-based menu?					
- How to mask the crickets as much as possible					
- Determining how much cricket content made it easier to eat					
- Figuring out the method of preparation					
- Deciding what other foods to pair with crickets					
- Masking the "cricket" impression					
- Not being able to use other protein sources					
7. How did you like today's sweet potato fries with cricket extract?					
Good	Bad	Did not eat			
30	0	2*			
8. Could you taste the cricket flavor in the sweet potato fries?					
Yes	No				
2	29				
9. How do you feel about eating crickets in their visible, whole form?					
Positive	Neutral	Negative			
6	5	21			
10. How do you feel about eating artificially farmed insects versus wild insects?					

Willing to eat both	Will eat farmed but not wild	Will eat wild but not farmed	Unwilling to eat either		
5	13	0	14		
11. If you have eaten insects outside of school lunch/class/club, which species?					
Crickets	Inago (grasshoppers)	Mealworms			
7	1	1			
12. Has eating insects changed your views on the environment, dietary habits, or insects in general?					
Yes	No	Unsure			
6	6	20			
13. In regions that have a traditional culture of eating insects, why do you think insects are still consumed today?					
Knowledge of benefits	Ease of collection	Culture/tradition	Currently, food is scarce	Nutritional value	Indispensable as food
1	2	10	3	7	1
14. Would you be willing to eat regionally traditional insects such as wasp larvae/pupae, grasshoppers, or silkworms?					
Yes	no				
9	23				
15. Why do you think insect-based foods are trending in Japan now?					
Concerning food shortages	For sustainability reasons	They're novel or interesting	High nutritional value	Because they taste good	Unsure
14	4	4	3	1	6

* One respondent stated that they had not eaten it; however, their answers to other questions assumed consumption, so we consider that response to be erroneous.

281

282 Discussion

283 Overall, many participants recognized the potential ecological benefits of
 284 edible insects but showed strong reluctance to consume them under normal circumstances.
 285 Although the school-wide lecture appeared to reduce some resistance—leading 66.4% of
 286 surveyed students to consider cricket-based dishes—approximately 70% still expressed
 287 discomfort toward eating insects in more recognizable forms (e.g., whole insects
 288 traditionally eaten in some regions of Japan). In group cooking sessions where crickets
 289 were visually and aromatically masked, students were more willing to taste it, but this did
 290 not necessarily translate into broader acceptance of other insect species or long-term
 291 changes in dietary preferences.

292

293 Mask Versus Recognition

294 One key observation is that masking insect characteristics (e.g., appearance or

smell) can initially lower reluctance and prompt students to sample insect-based dishes. However, 70% of group lunch participants still reported aversion to crickets' natural appearance. This masking strategy also limited participants' awareness of which insect they were actually consuming, thus preventing them from consciously recognizing insects as a legitimate food source. In other words, even if it is delicious, "unknowingly" eating insects did not necessarily deepen acceptance. Moreover, while hiding an insect's visual form may help first-timers overcome the "ick factor" (Caparros Megido *et al.*, 2014; Yen, 2009), it can also diminish the possibility of appreciating insects' unique traits. Many foods are valued for their recognizable taste and aroma, but these qualities are intentionally hidden in insect-based cooking to reduce psychological barriers. As a result, students gain only a partial, somewhat superficial acceptance of insects.

In contrast, students who prepared cricket dishes themselves seemed more open-minded. Even though they consciously masked the insects to accommodate inexperienced eaters, they treated crickets as valid ingredients—actively considering flavor, aroma, and appearance. They also tried to ensure that those who tasted the food found it enjoyable. These experiences suggest that hands-on engagement with insects in cooking might foster stronger acceptance than passive consumption of an unrecognizable product.

313

Students' Awareness of Entomophagy After the School-Wide Lecture

Given that 76.5% (257 out of 336) of the students ate cricket cookies but many of them still reported discomfort with other insects, it is estimated that at least 77% of students overall opposed eating insects in their traditional, recognizable forms.

Prior research, particularly in Japan, shows that cultural and historical contexts are instrumental in shaping attitudes toward entomophagy (Nonaka, 2005; Yen, 2009; Saga *et al.*, 2022). Other Japanese high schools introduced whole insects alongside lessons on local history, which reportedly reduced students' negative stereotypes (Saga *et al.*, 2022). By comparison, the school's initiative focused on combating food crises and environmental issues, but did not emphasize the cultural roots of insect-eating, potentially limiting students' motivation to try other insect species beyond crickets.

Indeed, cultural understanding and direct experience often work together (Onwezen *et al.*, 2019; Mancini *et al.*, 2019). Merely presenting sustainability benefits or high protein content may not be sufficient to shift entrenched attitudes. In contrast,

physically handling recognizable insects or learning about traditional food culture can encourage individuals to view insects as more than emergency rations or novelty items. In the practice of Saga *et al.* (2022), sensory factors such as “taste” and “texture,” along with regional identity, helped students accept entomophagy.

Practical Implications and Future Directions

Although masking insects effectively lowered initial resistance at the school, many students continued to perceive crickets as unusual, “emergency” foods rather than everyday proteins. These findings contrast with some previous research suggesting that masking insect features can increase general acceptance (Gmuer *et al.*, 2016; Lammers *et al.*, 2019; Mancini *et al.*, 2019). This discrepancy may reflect several factors, including publication bias in entomophagy research, where studies with positive outcomes may be more likely to be published than those with negative or neutral results. One possible explanation is that students, while understanding the link between insect consumption and global challenges, did not personally internalize those challenges—thus limiting deeper shifts in behavior or attitudes.

To achieve more meaningful acceptance, future curricula might incorporate more hands-on cooking opportunities. Students who cooked with crickets in this study deliberately explored the ingredient’s taste and aroma, ultimately recognizing its culinary potential. However, because many participants still dislike insects’ appearance, serving them whole may remain challenging in certain contexts. Another key idea is to introduce cultural-historical lessons, illustrating how insects have been used in local diets or how they became integral to regional food culture. Such an approach could help reposition insects from a “last-resort” protein to a legitimate, even heritage-based, food option. While the school offered cricket foods on multiple occasions, including cookies in June, croquettes in November, and sweet potato fries in February, more longitudinal studies are needed to determine whether repeat exposure fosters lasting acceptance. Questions remain about whether initial curiosity fades or, conversely, increases with repeated encounters. Gathering such data could guide more effective educational programs and inform public policy on integrating insect-based foods into mainstream diets. Finally, our findings suggest that simple masking alone may not promote entomophagy as a daily dietary choice, while hands-on cooking experiences show more promise. Future educational programs should consider combining direct exposure to insects’ distinctive

361 features with cultural and historical context to encourage deeper appreciation and genuine
362 dietary shifts.

363

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465 Figure 1. A) Lunch menu prepared for a group cooking class at the high school. The sweet
466 potato fries are in the upper right cup. B) Cricket extract dressed sweet potato fries.
467 All menu items, including the sweet potatoes, are self-serve.

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