

**Disgust for Sustainable Food Alternatives: Psychological Barriers to Diet Transition**

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**Author Note**

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### **Abstract**

Sustainable food alternatives such as insects, mycoprotein, and cultured meat have the potential to transform the environmental impact of present food systems, yet psychological barriers like disgust impede the widespread acceptance of these foods. Activation of the behavioral immune system may contribute to the disgust response and subsequent rejection of these foods. However, framing sustainable food alternatives as either high-status or low-status may mitigate these negative perceptions. In the first study, fabricated news articles were used to introduce participants to sustainable food alternatives and a self-report survey was used to measure the relationship between perceived vulnerability to disease, and disgust and willingness to consume. In the second study, sustainable food alternatives were framed in the articles as either high or low status to understand how this may change perceptions of the foods. Germ aversion, a subcategory of perceived vulnerability to disease, predicted greater disgust and reduced willingness to consume, although findings were more robust in Study 2 than in Study 1. Additionally, results demonstrated that insects consistently elicited increased disgust and decreased willingness to consume when compared to mycoprotein and cultured meat. Except for an increased willingness to consume cultured meat in the low-status framing condition, status framing did not affect disgust or willingness to consume. These results indicate that while germ aversion may influence the disgust and rejection of sustainable food alternatives, strategies beyond status framing may be necessary for promoting their acceptance. Future research should consider interventions that reduce the impact of germ aversion on consumer decision making.

*Keywords:* sustainable food alternatives, behavioral immune system, disgust

### **Disgust for Sustainable Food Alternatives: Psychological Barriers to Diet Transition**

One of the biggest questions of the modern era is how to feed a rapidly growing world population while at the same time reducing carbon emissions and limiting the use of natural resources. Advancements in food technology aimed at achieving these goals have allowed for the development of sustainable food alternatives, potentially offering a solution to this fundamental challenge (Parodi et al., 2018). Unfortunately, there are many barriers to making a large-scale switch to sustainable food alternatives, one of which is public acceptance. Previous literature demonstrates that when given the opportunity to try sustainable food alternatives like insects, mycoprotein, or cultured meat, people often react with neophobia, disgust, and ultimately rejection (Lammers et al., 2019; Onwezen et al., 2021; Ruby et al., 2015; Siegrist et al., 2018; White et al., 2023). However, the reasons for person-to-person variation in the strength of these disgust-rejection reactions are still unclear. The current study explored possible explanations for the disgust and rejection of sustainable food alternatives with the hopes of recommending an intervention which would increase public acceptance of these foods.

The universal goals of reducing world hunger, increasing worldwide quality of life, and protecting our environment for future generations will likely not be possible through the maintenance of current food systems. To reach the Paris Agreement goal of a global temperature increase of only 1.5 degrees Celsius, greenhouse gas emissions must drop 43% by 2030 (United Nations Framework Convention on Climate Change, n.d.). However, total demand for food is expected to increase 51% by 2050 (van Dijk et al., 2021). Current conventional farming practices for producing edible animal proteins such as beef, pork, and chicken are unsustainable due to their immense greenhouse gas emissions and the enormous strain they place on the Earth's natural resources (de Vries & de Boer, 2010; Gerber et al., 2015). Therefore, there is a significant

need to replace traditional protein sources with more sustainable alternatives. Insects, mycoprotein (fermented fungus), and cultured meat (lab-grown meat) are considered sustainable food alternatives because they have the potential to provide the necessary nutrients while taking up less land, using energy more efficiently, offering increased opportunities for the transition to renewable energy, and overall reducing environmental impact (Parodi et al., 2018). If these foods are so promising as sustainable replacements for products known to inflict excessive harm to the environment, why have we not successfully transitioned towards their use, or witnessed their widespread integration into Western diets? The resistance comes in part from Western consumers, many of which find the foods too disgusting and too foreign to try.

Understanding the psychological barriers that prevent the acceptance of sustainable food alternatives will be crucial for developing interventions that encourage the transition from traditional protein sources to sustainable food alternatives. Neophobia and disgust are common responses to sustainable food alternatives that prevent consumption (Chan, 2019; Hartmann et al., 2015; Koch et al., 2021; Tuorila & Hartmann, 2020). Neophobia, the fear of unfamiliar foods, can be traced back to our evolved need to avoid inedible, toxic, or otherwise harmful substances (Armelagos, 2014). Levels of food neophobia vary widely by individual depending on both genetic and environmental factors (Cooke, 2018). Disgust is a universal emotion that we evolved as a critical piece of our behavioral immune system which helps us avoid potential pathogens through our actions (Ackerman et al., 2018). For example, we may avoid eating rotting food because it disgusts us, but this action also reduces our chances of catching foodborne illness. Disgust also plays a role in preventing the violation of social norms which is adaptive for humans because we rely on social cohesion for survival (Fincher & Thornhill, 2012). Both disgust and neophobia serve important survival purposes, but they are maladaptive for promoting

a switch to sustainable food alternatives. Previous studies have demonstrated that individuals with high neophobia are unlikely to try sustainable food alternatives simply because they are unknown, and as would be expected, the more disgusting sustainable food alternatives are perceived to be, the more likely they are to be rejected (Chan, 2019; Hartmann et al., 2015; Koch et al., 2021, Tuorila & Hartmann, 2020). These studies have been essential in creating a baseline understanding of why people reject sustainable food alternatives, but there is still much unknown about the variations in behavior due to individual and situational differences.

One individual difference is the extent to which the behavioral immune system, our action-driven defense against infectious disease, has been activated. Active behavioral immune systems are linked to increased disgust, a mechanism for avoiding possible pathogens (Ackerman et al., 2018). Active behavior immune systems can also change individuals' behavior, leading them to adhere more closely to social norms, maintain conservative viewpoints, and even reject second-hand goods at a higher rate (Fincher et al., 2008; Huang et al., 2017; Murray & Schaller 2012; Schaller, 2016; Terrizzi et al., 2013). Within the context of food, perceived vulnerability to disease, a measure of the activation of the behavioral immune system, has been found to mediate the relationship between food neophobia and disgust (Santisi et al., 2021). Therefore, chronic activation of the behavioral immune system may elicit increased disgust for novel foods and motivate conformity to socially normative diets, prompting the rejection of socially devious sustainable food alternatives. Gaining insight into the role of the behavioral immune system appears essential to understanding why sustainable food alternatives have yet to be adopted by the Western Consumer. However, to the best of my knowledge, this concept has yet to be thoroughly investigated within the context of sustainable food alternatives, emphasizing the responsibility of the present study to address it.

Another goal of the current study was to introduce an intervention that may change the way sustainable food alternatives are perceived. If these foods are to be accepted into mainstream Western culture people must first overcome their disgust. There are three main ways to overcome disgust: denial, adaptation, and reframing (Rozin, 2008). Denial seems to be employed primarily when one has little ability to avoid repeatedly experiencing a disgusting situation, such as when one uses a public bathroom (Rozin, 2008). Since the incorporation of sustainable food alternatives into the diet can easily be avoided, denial will likely not be the correct method for overcoming disgust in this case. Both disgust and food neophobia can be reduced through repeated exposure, a process known as adaptation. While adaptation is likely the best strategy for long-term change, it is normally a gradual process that takes a long time and does not help with initial exposure. Reframing is thinking about a subject from an alternative perspective in order to reduce disgust (Rozin, 2008). Neophobia can also be reduced in this manner; for example, multiple studies found that people were more likely to consume insects when they were processed into powders or pieces rather than served whole (Hartmann et al., 2015; Lammers et al., 2019; Ruby et al., 2015). Without the whole insect visual cue, participants were likely better able to reframe the insects as food rather than as backyard creepy crawlies.

Reframing can also be related to social cues. When new foods are introduced, they often follow either a top-down (status based) or bottom-up (social proof) path before they are incorporated into mainstream culture. The top-down approach is when a small group of the social elite eat a new food as a “delicacy” which makes the food desirable for people in lower social classes (Ruby et al., 2015). Sushi provides an example of a foreign food which was incorporated into the Western cuisine through top-down processes. Before its sharp rise in popularity in the 1980s, sushi was met with similar disgust and rejection by the Western

consumer as many sustainable food alternatives are today (Brown, 2012). Considering the involvement of raw fish in sushi, the activation of the behavioral immune system could have been one aspect of this rejection. However, it seems likely that social norms also played a role in the initial disgust and rejection. At first sushi was a food only afforded by the elite consumer who sought an exotic and sophisticated cuisine (Hsin-I Feng, 2012). Less than a decade later, sushi became a common American food, a designation that was marked with the introduction of convenience-packaged sushi sold in grocery stores across the country (Brown, 2012).

Considering the original barriers, the progression from disgusting to high-class and then to commonplace took place very quickly. It seems possible that promoting a similar model for sustainable food alternatives could encourage fast adoption of these foods by Western consumers. The bottom-up approach occurs when a large population of lower social status incorporates a certain food into daily life until it becomes normalized (Ruby et al., 2015). Pizza, introduced by Italian immigrants at the beginning of the twentieth century is an example of a food that was normalized through bottom-up processes. Pizza was a cheap food well suited for feeding large quantities of working-class people who had little time to eat (Marino & Crocco, 2015). Pizza was considered an undesirable food, eaten only by the poor, until after World War Two when it became widely accepted as a social food even among the middle and upper class (Helstosky, 2008). This bottom-up process offers an alternative route for new foods to be accepted. Optimal framing of sustainable food alternatives may depend on beliefs already held about that food and their interaction with other factors such as the behavioral immune system.

The current study investigated the relationship between activation of the behavior immune system and disgust and rejection of sustainable food alternatives. I hypothesized that those with higher perceived vulnerability to disease (split into the sub-categories germ aversion

and perceived infectability) would be more disgusted and less likely to consume sustainable food alternatives, because of the chronic activation of their behavioral immune system. A strong relationship between perceived vulnerability to disease and disgust for sustainable food alternatives would suggest that interventions that target behavior change should be most effective on people with low perceived vulnerability to disease. Next, the current study presented an intervention that explored the best way to introduce sustainable food alternatives to Western culture. By framing the foods as either high or low in socioeconomic status (SES), the current study investigated the potential of top-down or bottom-up processes. Since food presents an avenue through which one may gain social status (Johnston & Baumann, 2009), I hypothesized that when sustainable food alternatives were framed as high-SES, participants would be less disgusted and more willing to consume the foods than when they were framed as low-SES. I also hypothesized that there would be an interaction between perceived vulnerability to disease and SES framing. When participants were high in perceived vulnerability to disease, I expected that they would reject sustainable food alternatives, regardless of how they were framed, as survival takes precedence over status improvement.

### **Method Study 1**

#### **Participants**

Participants were undergraduate adults ages 18-23 from the University of Michigan subject pool recruited in exchange for class credit. A total of 110 participants were recruited. Four participants who indicated that they kept a vegan or vegetarian diet were excluded from the study post-hoc, because they avoid certain meat products due to objections, often moral, beyond the scope of the current study. The resulting number of participants was  $N = 106$ . Demographic information is listed in Table 1.



**Table 1***Sample Descriptive Statistics*


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	Frequency (%)
<b>Gender</b>	
Male	41 (39%)
Female	63 (59%)
Genderqueer (Self Identified)	1 (.9%)
N/A	1 (.9%)
<b>Ethnicity</b>	
White or European American	48 (45%)
Black or African American	6 (6%)
Asian or Asian American	23 (22%)
Hispanic or Latino	8 (8%)
Middle Eastern or North African	4 (4%)
Multiple Ethnicities	16 (15%)
N/A	1 (.9%)

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*Note.* Ethnicity percentages may not add up to 100% because participants with multiple ethnicities were included in individual ethnicity counts as well as the “Multiple Ethnicities” count.

**Measures***Descriptive Articles*

A brief description about each sustainable food alternative, which roughly mimicked the format of a news article, was provided to participants. The description gave details about how the food was made (if applicable) and listed potential dishes in which the food could be incorporated. The purpose of this description was to introduce each sustainable food alternative, giving enough details to allow the participants to immerse themselves in an imagined experience of encountering these foods. In order to keep consistent the manner and tone in which each sustainable food alternative was described, the descriptions were compared to one another to ensure they were similar using Linguistic Inquiry and Word Count (LIWC) ratings which are

included in Table 2 (“*LIWC — Try It Now*”, n.d.). The full descriptive articles are provided in the appendix.

**Table 2**

<i>LIWC Rating</i>			
	Insects	Mycoprotein	Cultured Meat
Positive Tone	1.32	1.41	1.5
Negative Tone	0	0	0
Social Words	1.32	2.82	1.5
Cognitive Processes	12.58	11.97	11.28
Allure	0	0	0
Moralization	0	0	0
Word Count	151	142	133

### ***Disgust and Willingness to Consume***

Following each descriptive article participants answered questions developed from Hartmann and Siegrist (2018) and Lammers et al. (2019) about their disgust and willingness to consume the sustainable food alternative mentioned in the article. An example of a Disgust measure is “How disgusting would it be to eat (*insert food*)” on a seven-point Likert scale from *Not at all disgusting* to *Very disgusting*. An example of a Willingness to Consume measure is “How likely is it that you would try (*insert food*)?” on a seven-point Likert scale from *Very Unlikely* to *Very Likely*.

### ***Social Class Perceptions***

Next, participants responded to questions which aimed to measure perceptions about which social classes and SES groups are most likely to eat each sustainable food alternative. This measure was important for determining if there were any consistent pre-existing beliefs about the foods that could limit the effectiveness of the SES framing manipulation in Study 2. Social class perception questions included “If you had to position the people most likely to eat (*insert food*)

on a scale of socioeconomic status (SES), where would you place them?” answered using a seven-point Likert scale from *Extremely Low SES* to *Extremely High SES*. SES and social class were defined prior to the question using work by Rubin et al. (2014) as “the current social and economic situation of an individual” and “the social and economic background of an individual” respectively. We tested for a correlation between SES and social class questions to see if we could combine these measures, but determined the correlations for insects (.66), mycoprotein (.67), and cultured meat (.68) were all too small to combine the SES and social class items.

### ***Control Questions***

A measurement of food familiarity was included because familiarity may reduce food neophobia and lead to greater willingness to consume (Lammers et al., 2019; Verbeke et al., 2015). Food familiarity was measured as a categorical variable (where 1 represented participants who had neither heard of nor tried the food of interest, 2 represented participants who had heard of but not tried the food of interest, and 3 represented participants who had both heard of and tried the food of interest). Questions on the consumption of meat in the diet and religious diet were also included because vegans and vegetarians may not be willing to eat insects or cultured meat and might be more interested in substituting mycoprotein for meat-based proteins (Lammers et al., 2019; Verbeke et al., 2015), and people who keep religious diets may have a moral objection to certain foods which motivates their food preferences (Hamerman et al., 2019). Questions which measured these variables were included to allow for either post-hoc exclusion of participants or statistical control during analysis.

### ***Disease and Social Class***

Before framing each food by SES in Study 2, we wanted to collect data to determine the extent to which disease threats are associated with high or low social classes. Strong beliefs that

lower social classes face greater disease threat and higher social classes face less disease threat would suggest that those with high perceived vulnerability to disease will react with increased levels of disgust and be less willing to consume foods when they are framed as low class. In order to determine the extent to which disease threat is perceived to be associated with high or low social class participants were asked questions such as “Rate your agreement to the following question. If an infectious disease (such as a cold, the flu, E. coli/food poisoning or any other contagious illness) is going around, people from lower social classes will be more likely to catch it?” with a seven-point Likert scale from *strongly disagree* to *strongly agree*.

### ***Perceived Vulnerability to Disease***

Data about germ aversion and perceived infectability, both under the umbrella of perceived vulnerability to disease, was collected using the self-report instrument developed by Duncan et al. (2009).

### **Procedure**

Approval for both Study 1 and Study 2 was received from the University of Michigan IRB September 20th, 2023. Up to four participants were brought into the lab room at a time where they were assigned to a computer to take the online survey. A within-subject design was used for the variable Food Type, so all participants were exposed to the descriptive article for each food. After being introduced to the sustainable food alternative through the descriptive article, participants answered questions on their disgust, willingness to consume, and social class perceptions related to the food. Control measures, disease and social class perceptions, and perceived vulnerability to disease were collected after participants had completed the measures relating to all three foods. Demographic information was collected at the end of the survey. Upon completion of all questions, participants were debriefed on the purpose of the study.

### **Analysis Plan**

In this mixed-design study, Disgust, Willingness to Consume, and Familiarity were measured independently for each of the three foods, resulting in three separate measurements per participant for these variables. In contrast, the participant's perceived vulnerability to disease (Germ Aversion and Perceived Infectability) was measured only once. Perceived vulnerability to disease was tested as a predictive variable for both Disgust and Willingness to Consume across all three foods. This study design necessitated the use of random effects to properly address the non-independence of measurements. By statistically controlling for variation between participants, inherent correlations within the participants' responses across the different foods were accounted for.

Possible models of the independent variables (Germ Aversion, Perceived Infectability, Familiarity, Religious Diet, and Food Type) and dependent variables (Disgust and Willingness to Consume) of interest were constructed and compared using Akaike information criterion (AIC). Akaike weight indicates the predictive value of a specific model compared to all the other models included in the analysis. For example, a model with Akaike Weight .10 has a 10% chance of being the best model among the provided models. To assess the significance of individual variables across models, the Akaike weights from all the models containing that variable are combined. This combined Akaike weight acts as an indicator of the variable's overall importance in explaining the dependent variable.

Top models which carried more than 1% of the model weight were then used to aggregate beta coefficients and create confidence intervals. This method was used because modeling averaging is best practice for computing a single, more robust prediction (Burnham et al., 2011). Aggregated beta coefficients communicate the effect size of a predictor on the dependent

variable when all other predictors are held constant. For example, an averaged beta coefficient of two would tell us that for every unit increase in the predictor variable, the dependent variable increases by a magnitude of two units.

A common criticism of AIC comparison is that it can only be used in an exploratory context and not for confirming or denying specific hypotheses. Typical methods of analyzing the data would test the hypotheses of interest against a null hypothesis, which states that there is exactly no effect. Specifically, in the context of the current study, it asserts that the independent variables of interest (Germ Aversion, Perceived Infectibility, Food Type, Familiarity, and Religious Diet) have exactly zero correlation with the dependent variable (Disgust or Willingness to Consume). Anderson (2008), on page 12 of his discussion on model-based inference, notes that when the null hypothesis seems implausible at best, it provides a bad standard against which to test alternative hypotheses. AIC comparison treats each model as a hypothesis and compares these hypotheses to each other, rewarding models that better fit the data while also penalizing for complexity. The best models can be used to extrapolate effect sizes and confidence intervals which provide evidence for understanding the impact of each independent variable. For example, in the current study the inclusion of Germ Aversion in the majority of top models would provide initial evidence that this variable is valuable for predicting the dependent variable. The averaged model Germ Aversion beta coefficient then gives a maximum likelihood estimate of the strength of the effect, and the confidence interval tells us how confident we can be in the direction and magnitude of that effect. If the confidence interval overlaps with zero, we cannot be confident in the direction of the effect or that there is an effect at all, which provides evidence against the hypothesis that Germ Aversion is a significant predictor. If the confidence interval does not overlap with zero, it provides further evidence that Germ Aversion is a

significant predictor. While AIC comparison and the aggregation of top models discourages outright rejection or acceptance of any one hypothesis, perhaps a weakness when compared to the direct and binary method of null hypothesis testing, it provides substantial evidence for supporting or opposing the role independent variables play in predicting the dependent variables while also providing information about the magnitude of that role. Furthermore, it avoids reliance on p-values with arbitrary cutoffs and the issues that can accompany null hypothesis significance testing (NHST) such as p-hacking.

### AI Usage

OpenAI's ChatGPT-4 was used to create drafts of the descriptive articles, which were then edited to fit the needs of the study. Additionally, ChatGPT-4 assisted with coding analysis and data visualizations in RStudio. Finally, ChatGPT-4 served as a text editing tool for correcting minor grammatical, spelling, or punctuation errors in the current manuscript.

### Results Study 1

Among the 28 models assessed using AIC, models with a cumulative AIC weight  $> 0.99$  were identified for both Disgust and Willingness to Consume. Top models for Disgust and Willingness to Consume are listed in Tables 3 and 4 respectively.

**Table 3**

*Disgust Models Akaike Weight  $> .01$*

Model	Akaike Weight
Disgust ~ (1   Participant) + Food Type + Familiarity	0.3745
Disgust ~ (1   Participant) + Germ Aversion + Food Type + Familiarity	0.2534
Disgust ~ (1   Participant) + Food Type + Familiarity + Religious Diet	0.1342
Disgust ~ (1   Participant) + Germ Aversion + Food Type + Familiarity + Religious Diet	0.0848
Disgust ~ (1   Participant) + Percieved Infectability + Food Type + Familiarity	0.0407
Disgust ~ (1   Participant) + Percieved Infectability + Germ Aversion + Food Type + Familiarity	0.0288
Disgust ~ (1   Participant) + Percieved Infectability + Food Type + Religious Diet + Familiarity	0.0148
Disgust ~ (1   Participant) + Food Type	0.0142
Disgust ~ (1   Participant) + Germ Aversion + Food Type	0.0123
Disgust ~ (1   Participant) + Germ Aversion + Food Type + Familiarity + Germ Aversion* Food Type	0.0116

**Table 4***Willingness to Consume Models Akaike Weight > .01*

Model	Akaike Weight
WTC ~ (1   Participant) + Food Type + Familiarity	0.5852
WTC ~ (1   Participant) + Food Type + Familiarity + Religious Diet	0.2029
WTC ~ (1   Participant) + Percieved Infectability + Food Type + Familiarity	0.0822
WTC ~ (1   Participant) + Germ Aversion + Food Type + Familiarity	0.0530
WTC ~ (1   Participant) + Percieved Infectability + Food Type + Religious Diet + Familiarity	0.0275
WTC ~ (1   Participant) + Germ Aversion + Food Type + Familiarity + Religious Diet	0.0184
WTC ~ (1   Participant) + Germ Aversion + Food Type + Familiarity + Germ Aversion* Food Type	0.0103

Food Type was included in all the top models providing initial evidence that this variable was a significant predictor of both Disgust and Willingness to Consume. Insects served as the reference category represented by the intercept. The averaged Disgust model intercept indicated the baseline level of Disgust towards insects of  $\beta = 5.98$ , 95% CI [4.57, 7.40] when holding all other variables constant. Compared to insects, mycoprotein and culture meat both predicted decreased Disgust, with averaged model effect sizes of  $\beta = -2.60$ , 95% CI [-3.18, -2.03] and  $\beta = -2.40$ , 95% CI [-2.88, -1.92], respectively. The baseline Willingness to Consume for insects while holding other variables constant was  $\beta = 0.57$ , 95% CI [-0.26, 1.40]. Both mycoprotein and cultured meat predicted an increased Willingness to Consume  $\beta = 1.75$ , 95% CI [1.29, 2.22],  $\beta = 1.85$ , 95% CI [1.44, 2.26] when compared to insects.

**H1:**

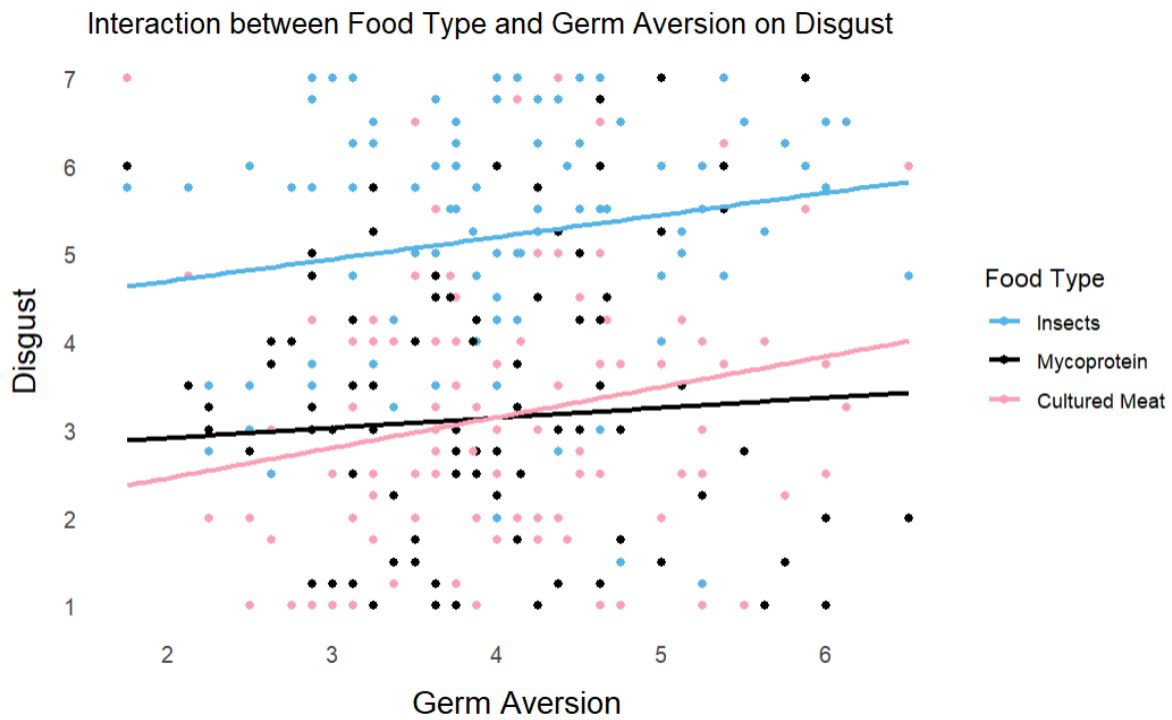
It was hypothesized that increased perceived vulnerability to disease, split into Germ Aversion and Perceived Infectability, would predict greater Disgust and lower Willingness to Consume. Germ Aversion was included in top Disgust models with a combined Akaike weight of .40 providing a moderate initial level of support for Germ Aversion as a variable which affects Disgust. The averaged Disgust model effect size for Germ Aversion was  $\beta = 0.22$  accompanied by confidence intervals that just barely encompass zero 95% CI [-0.01, 0.45]. Although it



appears there was a positive relationship between Germ Aversion and Disgust, we have limited confidence in the presence of the effect. There was less evidence that Germ Aversion was a predictor of Willingness to Consume with a relatively low combined Akaike weight of .07 and an averaged model effect size of  $\beta = -0.01$ , 95% CI  $[-0.22, 0.20]$ . There was little evidence for Perceived Infectibility as a predictor of either Disgust or Willingness to Consume. In the Disgust models, Perceived Infectibility was included in models which only accounted for collectively for .08 of the Akaike weight and had an averaged model effect size of  $\beta = 0.01$ , 95% CI  $[-0.22, 0.25]$ . In Willingness to Consume models, Perceived Infectibility was included in the models which had a collective Akaike weight of .11, with an averaged model effect size of  $\beta = 0.09$ , 95% CI  $[-0.09, 0.28]$ . There was no interaction between Food Type and Germ Aversion or Food Type and Perceived Infectibility on either Disgust or Willingness to Consume, indicated by the exclusion of interactions from top models, and interaction averaged beta coefficients that were less than 0.01 with confidence intervals that overlapped zero. Figures 1 and 2 visualize the relationship between Food Type and Germ Aversion on Disgust and Willingness to Consume, the most relevant results for addressing the first hypothesis.

**Figure 1**

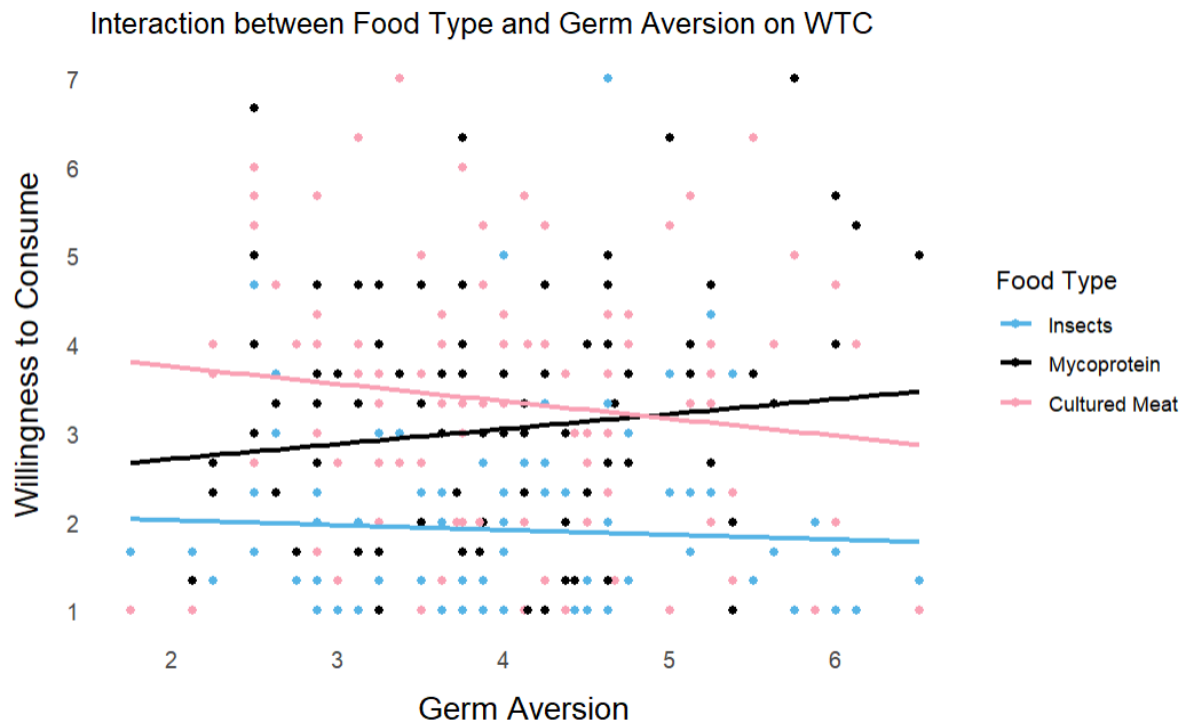
*Graph of Germ Aversion as a predictor of Disgust by Food Type*



*Note.* Although there appears to be an interaction between Germ Aversion and Food Type, this effect was negligible and not confirmed by analysis.

**Figure 2**

*Graph of Germ Aversion as a predictor of Willingness to Consume by Food Type*



*Note.* There was no main effect of Germ Aversion on Willingness to Consume. Although there appears to be an interaction between Germ Aversion and Food Type, this effect was negligible and not confirmed by analysis.

### Other Predictors

Familiarity and Religious Diet were included in some models as control variables. Familiarity was included in Disgust models with a combined Akaike weight of .94, providing a high initial level of support for Familiarity as an influential variable, and had an averaged model effect size of  $\beta = -0.55$ , 95% CI  $[-0.90, -0.21]$ . Familiarity was included in Willingness to Consume models with a combined Akaike weight of .95, and had an averaged model effect size of  $\beta = 0.60$ , 95% CI  $[0.30, 0.89]$ . Based on this data we can conclude that Familiarity was a significant predictor of reduced Disgust and increased Willingness to Consume.

Religious Diet was included in the Disgust models which accounted for .23 of the Akaike weight with an averaged model effect size of  $\beta = 0.14$ , 95% CI  $[-0.56, 0.83]$ , and the Willingness to Consume models with .25 Akaike weight and averaged model effect size of  $\beta = -0.20$ , 95% CI  $[-0.80, 0.39]$ . The low cumulative Akaike weights along with the confidence intervals that overlap zero demonstrate that Religious Diet is not a significant predictor of Disgust or Willingness to Consume.

### **Missing Data**

Missing data was treated as missing completely at random. Four participants missed one to three items on the perceived vulnerability to disease measure. Germ Aversion and Perceived Infectability were calculated for these participants using the remaining items.

### **Study 1 Results Summary**

Overall, there was limited support for the first hypothesis that perceived vulnerability to disease predicts increased Disgust and decreased Willingness to Consume. Study 1 found an effect of Food Type where participants were more disgusted and less willing to try insects. Additionally, with limited confidence, we found a very small positive relationship between Germ Aversion and Disgust, but not Germ Aversion and Willingness to Consume. Familiarity had a positive relationship with Willingness to Consume and a negative relationship with Disgust. All other variables were not predictive of Disgust or Willingness to Consume.

Study 2 was a follow up to Study 1 which followed the same basic methodology but introduced status framing conditions. The news articles from Study 1 were extended to include a paragraph that framed each food as a high-SES food or low-SES food depending on the condition. The dependent variables of interest were the same as in Study 1, Disgust and Willingness to Consume.

## **Method Study 2**

### **Preliminary Tests**

To determine our ability to manipulate perceptions of each of the foods for Study 2 it was necessary to explore pre-existing associations between specific sustainable food alternatives and SES and social class. The mean of SES and social class association items were calculated for each food. If the SES mean was above two or below six (on a 7-point scale) or if the social class mean was above four or below two (on a 5-point scale) it would indicate sentiments too strong for including that food in Study 2. The mean SES scores for insects, mycoprotein, and cultured meat were 3.4, 4.5, and 4.3 respectively, and the mean social class scores were 2.5, 3.3, and 3.2. None of the means met the criteria for exclusion, so we decided to keep all foods for Study 2.

An exploratory analysis, intended to inform the hypotheses of Study 2, explored the extent to which disease is associated with high or low social class. On a scale where seven indicates a strong association with the lower class and one represents a strong association with the higher class, the mean score was 5.3. This suggests a slight association of disease with the lower social class. This informed the hypothesis for Study 2 that framing the foods as high-SES might reduce disgust and increase willingness to consume, because the foods would be less associated with disease.

### **Participants**

Participants were undergraduate adults ages 18-21 from the University of Michigan subject pool recruited in exchange for class credit. A total of 165 participants were recruited. Data from five participants was excluded due to research assistants' notes on their inattention and the excessive speed at which they took the survey (< 5 min). As an amendment to Study 1, four participants who indicated that they lived the majority of their life in a non-western country

(India, South Korea, China) were excluded from the study post-hoc because different cultural norms would likely change their perceptions of sustainable food alternatives, and the current study focuses on the perceptions of people from Western countries. Eight participants who indicated that they kept a vegan or vegetarian diet were also excluded from the study post-hoc. The resulting number of participants was  $N = 148$ . Demographic information is listed in Table 5.

**Table 5***Sample Descriptive Statistics*

	Frequency (%)
Gender	
Male	50 (34%)
Female	96 (65%)
Non-Binary/Third Gender	1 (.7%)
N/A	1 (.7%)
Ethnicity	
White or European American	35 (24%)
Black or African American	6 (4%)
Asian or Asian American	48 (32%)
Hispanic or Latino	18 (12%)
Middle Eastern or North African	9 (6%)
Multiple Ethnicities	31 (21%)
N/A	1 (.7%)

*Note.* Percentages may not add up to 100% because participants with multiple ethnicities were included in individual ethnicity counts as well as the “Multiple Ethnicities” count.

**Measures***Framed Articles*

Based on the results of Study 1, which did not show strong pre-existing associations between specific sustainable food alternatives and SES or social class, it was concluded that the Study 2 SES manipulation was likely to be successful on all three foods. Therefore, all three foods were selected to be included in Study 2. Participants were introduced to each sustainable

food alternative using the same descriptive articles used in Study 1, but each article also included a fabricated paragraph following the descriptor paragraph which framed the sustainable food alternatives as either high or low-SES. This paragraph presented a news story about the food in the context of the corresponding framing condition. For example, when foods were in the high-SES condition they were described as luxurious, expensive, and marketed by upscale establishments. When foods were in the low-SES condition they were described as casual, affordable, and marketed by informal establishments. Similarly to Study 1, LIWC ratings, which are included in Table 6, were kept as consistent as possible between all articles (“*LIWC — Try It Now*”, n.d.). The full framed articles are provided in the appendix.

**Table 6***LIWC Rating*

Framing Condition	High SES	Low SES	High SES	Low SES	High SES	Low SES
	Insects	Insects	Mycoprotein	Mycoprotein	Cultured Meat	Cultured Meat
Positive Tone	3.02	2.96	3.36	3.42	2.78	2.77
Negative Tone	0	0	0	0	0	0
Social Words	3.36	2.96	3.02	3.08	2.08	2.08
Cognitive Processes	8.72	8.22	9.06	8.56	9.37	9.34
Allure	2.35	2.63	3.69	3.42	2.43	2.77
Moralization	0	0	0	0	0	0
Word Count	298	304	298	292	288	289

*Survey Questions*

All the survey questions were the same as Study 1, but with the exclusion of the Disease and Social Class measure. Items in the Social Class Perceptions measure were used as a manipulation check.

**Procedure**

The procedure remained the same as Study 1 except that all participants were randomly assigned into either a high or low-SES framing condition. Participants then read the framed

articles about each of the three foods and responded to the corresponding questions. All three foods were consistently framed according to the status framing condition in which the participant was placed. Demographic information was collected at the end of the survey. Upon completion of all questions, participants were debriefed on the purpose of the study.

### **Analysis Plan**

As with Study 1, random effects were used to properly address the non-independence of measurements of participant Germ Aversion and Perceived Infectability. By statistically controlling for variation between participants, inherent correlations within the participants' responses across the different foods were accounted for.

Possible models of the independent variables (Germ Aversion, Perceived Infectability, Familiarity, Religious Diet, Food Type and Condition) and dependent variables (Disgust, Willingness to Consume) of interest were constructed and compared using AIC comparison. Top models which carried more than 1% of the model weight were used to aggregate beta coefficients and create confidence intervals. The implementation of this statistical method over traditional NHST was selected for the same reasons as listed in the Analysis Plan of Study 1.

### **AI Usage**

OpenAI's ChatGPT-4 was used similarly to Study 1, to create drafts of the framed articles, assist with coding in RStudio, and check for minor written errors.

## **Results Study 2**

The manipulation check, which asked participants to position the people most and least likely to eat the food mentioned in the article on a scale of SES, explored the extent to which the SES manipulation was successful. In the high-SES condition, average SES scores for insects, mycoprotein, and cultured meat were 4.26, 5.34, and 5.61 respectively, with one representing



extremely low-SES and seven representing extremely high-SES. Although all scores were above the midpoint of four, a one-level t-test demonstrated that while scores for mycoprotein and cultured meat were significantly different from the midpoint,  $t(76) = 7.50, p < .001$ ;  $t(76) = 9.29, p < .001$ , scores for insects were not  $t(76) = 1.15, p = 0.253$ . In the low-SES condition, average SES scores for insects, mycoprotein, and cultured meat were 2.80, 3.21, and 2.89 respectively. All scores were significantly below the midpoint of four,  $t(70) = -6.38, p < .001$ ;  $t(70) = -3.50, p < .001$ ;  $t(70) = -5.37, p < .001$ . It can be concluded that the manipulation was successful with the exception of the high-SES insect condition.

Among the 53 models assessed using AIC, models with a cumulative AIC weight  $> .99$  were identified for both Disgust and Willingness to Consume. Top models for Disgust and Willingness to Consume are listed in Table 7 and Table 8 respectively.

**Table 7**

*Disgust Models Akaike Weight > .01*

Model	Akaike Weight
Disgust ~ (1   Participant) + Germ Aversion + Food Type + Familiarity	0.4990
Disgust ~ (1   Participant) + Germ Aversion + Food Type + Familiarity + Religious Diet	0.1996
Disgust ~ (1   Participant) + Condition + Germ Aversion + Food Type + Familiarity	0.1028
Disgust ~ (1   Participant) + Percieved Infectability + Germ Aversion + Food Type + Familiarity	0.0448
Disgust ~ (1   Participant) + Condition + Germ Aversion + Food Type + Familiarity + Religious Diet	0.0391
Disgust ~ (1   Participant) + Germ Aversion + Food Type + Familiarity + Germ Aversion* Food Type	0.0388
Disgust ~ (1   Participant) + Condition + Food Type + Familiarity + Germ Aversion + Condition*Germ Aversion	0.0248
Disgust ~ (1   Participant) + Condition + Food Type + Familiarity + Germ Aversion + Condition*Food Type	0.0183
Disgust ~ (1   Participant) + Percieved Infectability + Germ Aversion + Food Type + Familiarity+ Religious Diet	0.0181

**Table 8***Willingness to Consume Models Akaike Weight > .01*

Model	Akaike Weight
WTC ~ (1   Participant) + Condition + Food Type + Familiarity + Germ Aversion + Condition*Food Type	0.4372
WTC ~ (1   Participant) + Food Type + Familiarity	0.1437
WTC ~ (1   Participant) + Condition + Germ Aversion + Food Type + Familiarity	0.1383
WTC ~ (1   Participant) + Condition + Food Type + Familiarity + Condition*Food Type	0.1038
WTC ~ (1   Participant) + Condition + Germ Aversion + Food Type + Familiarity + Religious Diet	0.0396
WTC ~ (1   Participant) + Percieved Infectability + Germ Aversion + Food Type + Familiarity	0.0339
WTC ~ (1   Participant) + Condition + Food Type + Familiarity + Germ Aversion + Condition*Germ Aversion	0.0331
WTC ~ (1   Participant) + Food Type + Religious Diet + Familiarity	0.0323
WTC ~ (1   Participant) + Percieved Infectability + Food Type + Familiarity	0.0109
WTC ~ (1   Participant) + Percieved Infectability + Germ Aversion + Food Type + Familiarity + Religious Diet	0.0109

As in Study 1, Food Type was included in all top models with insects as the reference category represented by the intercept. When holding all other variables constant, the averaged Disgust model intercept indicated the baseline level of Disgust towards insects of  $\beta = 5.30$ , 95% CI [4.14, 6.47]. Compared to insects, mycoprotein and culture meat both predicted decreased levels of Disgust with averaged model effect sizes of  $\beta = -2.75$ , 95% CI [-3.32, -2.18] and  $\beta = -2.49$ , 95% CI [-3.04, -1.93] respectively. The baseline Willingness to Consume for insects while holding other variables constant was  $\beta = 1.32$ , 95% CI [0.33, 2.30]. Mycoprotein and cultured meat each predicted greater Willingness to Consume than insects  $\beta = 1.44$ , 95% CI [1.10, 1.79],  $\beta = 1.62$ , 95% CI [1.32, 1.92].

**H1:**

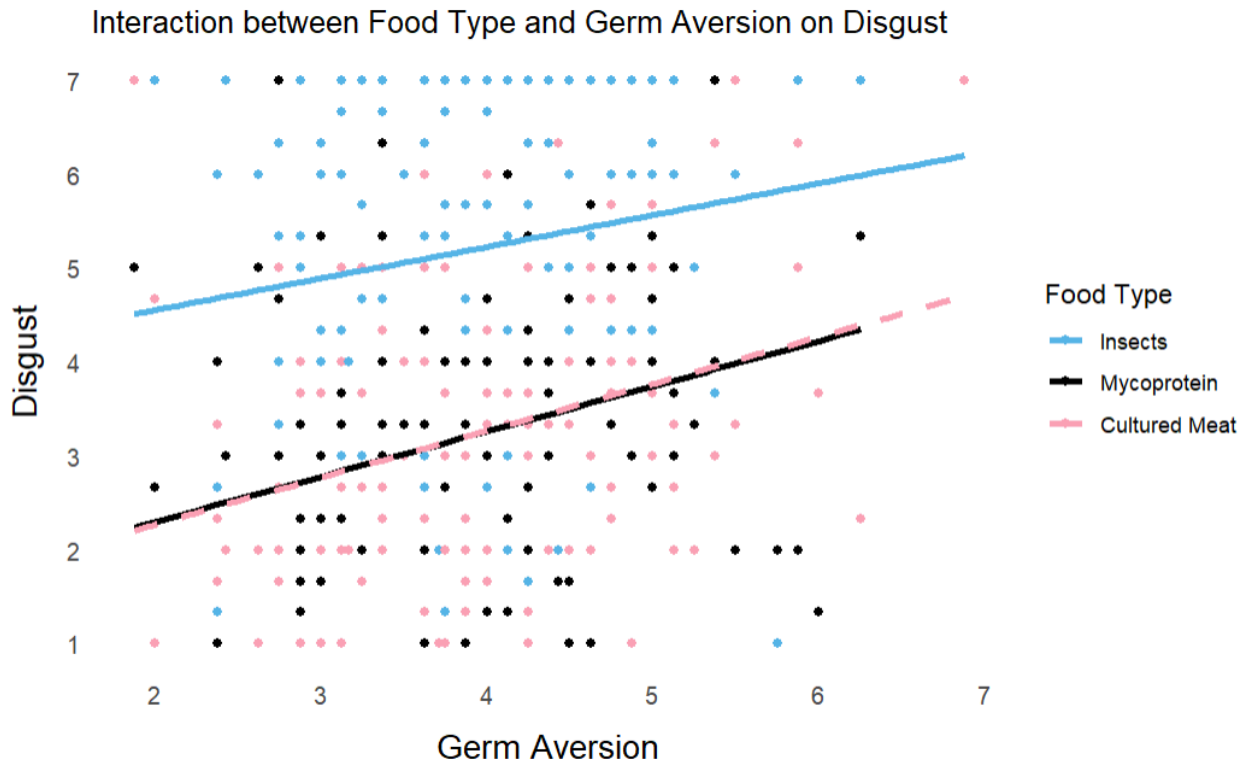
The hypothesis that perceived vulnerability to disease, split into Germ Aversion and Perceived Infectability, would be a predictor of greater Disgust and lower Willingness to Consume was tested again in Study 2. Germ Aversion was included in all Disgust models with an Akaike weight above .01, providing a strong initial level of support for Germ Aversion as a variable which predicts Disgust. The averaged Disgust model effect size for Germ Aversion was  $\beta = 0.39$  accompanied by confidence intervals 95% CI [0.17, 0.62]. Germ Aversion was included

in the Willingness to Consume models with a moderate combined Akaike weight of .69. The averaged Willingness to Consume model effect size for Germ Aversion was  $\beta = -0.22$  accompanied by the confidence interval 95% CI  $[-0.37, -0.06]$ . The inclusion of Germ Aversion in the vast majority of top models, along with effect sizes with confidence intervals that did not overlap with zero, are evidence that Germ Aversion predicts increased Disgust and reduced Willingness to Consume as hypothesized. Perceived Infectibility was included in Disgust models with a small combined Akaike weight of .06 and an effect size of  $\beta = 0.03$ , 95% CI  $[-0.16, 0.21]$ , and in Willingness to Consume models with combined Akaike weight of .06 and effect size of  $\beta = 0.01$ , 95% CI  $[-0.13, 0.15]$ . The absence of this variable in most of the top models along with effect sizes with confidence intervals that overlapped with zero are evidence that unlike Germ Aversion, Perceived Infectibility was not a significant predictor.

Interactions between Germ Aversion and Food Type did not appear a significant predictor of Disgust for mycoprotein  $\beta = 0.21$ , 95% CI  $[-0.10, 0.53]$  or cultured meat  $\beta = 0.25$ , 95% CI  $[-0.07, 0.56]$  when compared to the reference category of insects. Germ Aversion and Food Type interactions were not included in any of the top Willingness to Consume models. Perceived Infectibility and Food Type interactions were excluded from both Disgust and Willingness to Consume models with Akaike weight above .01. Figures 3 and 4 illustrate the main effect of Germ Aversion on Disgust and Willingness to Consume across the three foods.

**Figure 3**

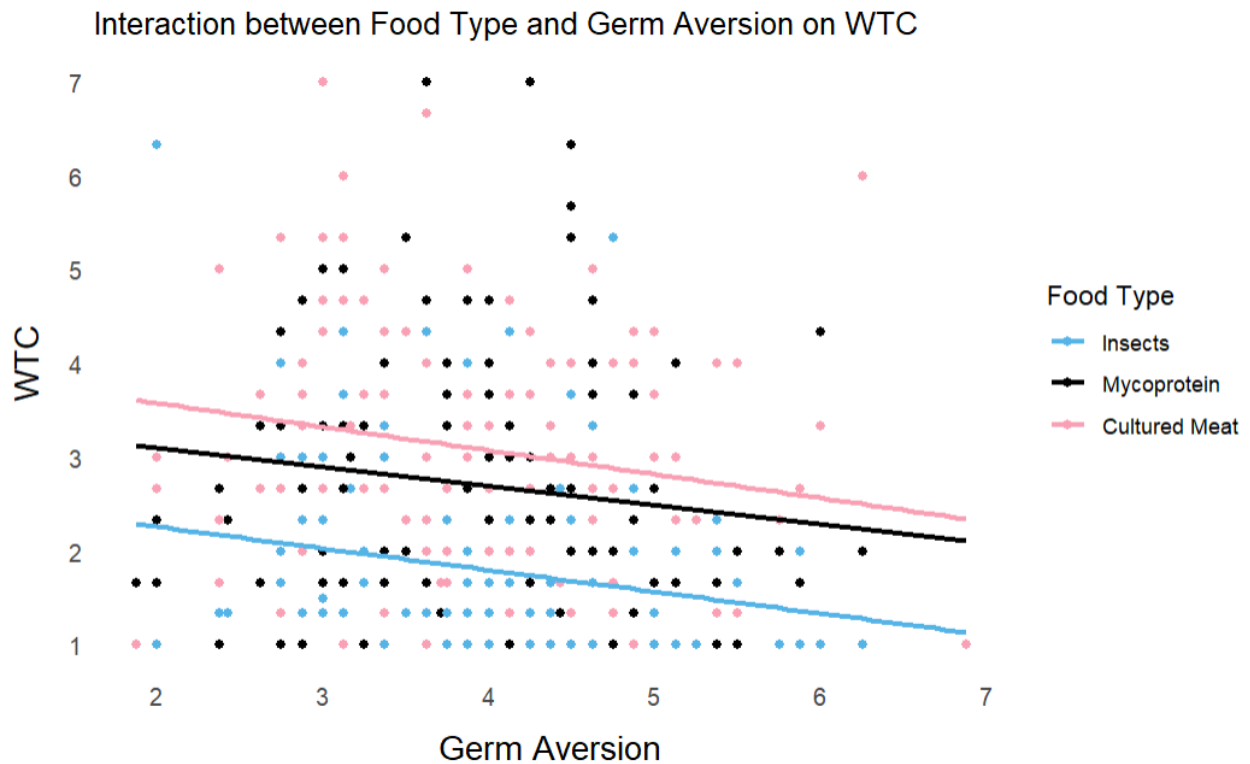
*Graph of Germ Aversion as a predictor of Disgust by Food Type*



*Note.* The regression line for cultured meat is dotted because it overlaps with the regression line for mycoprotein.

**Figure 4**

*Graph of Germ Aversion as a predictor of Willingness to Consume by Food Type*

**H2:**

It was hypothesized that participants in the high-SES framing condition would report less disgust and more willingness to consume than participants in the low-SES framing condition. Condition was included in Disgust models collectively accounting for .19 of Akaike weight. Since insects were the reference category, the averaged model main effect refers to the difference between Conditions for insects, while the interaction averaged beta coefficients refer to the difference between Conditions for mycoprotein and cultured meat. There was no difference in Disgust between Conditions for insects  $\beta = -0.02$ , 95% CI  $[-0.82, 0.78]$ , nor was there evidence that Condition was a predictor of Disgust for mycoprotein  $\beta = 0.08$ , 95% CI  $[-0.49, 0.65]$  or

cultured meat  $\beta = -0.32$ , 95% CI  $[-0.89, 0.25]$ . Figure 5 visualizes the relationship between Condition and Food Type on Disgust.

**Figure 5**

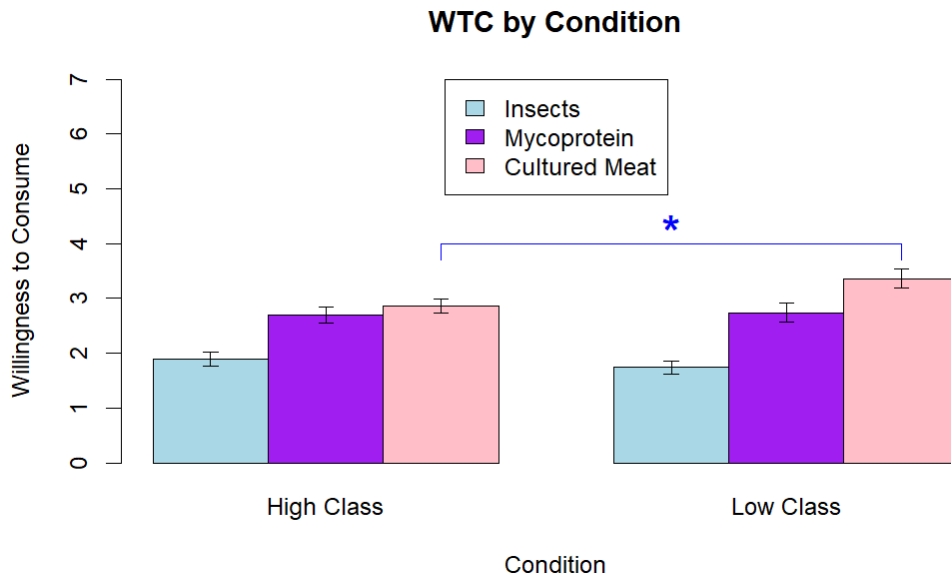
*Bar graph of Disgust by Social Framing Condition and Food Type*



Condition was included in Willingness to Consume models with a cumulative Akaike weight of .75, presenting strong initial evidence for Condition as a variable which impacts Willingness to Consume. Again, insects were used as the reference category, with the averaged main effect of Condition  $\beta = -0.01$ , 95% CI  $[-0.60, 0.59]$ , providing no evidence for a difference in Willingness to Consume for insects between Conditions. There also appeared to be no difference in Willingness to Consume for mycoprotein between Conditions as seen by the averaged interaction beta coefficient and confidence interval  $\beta = 0.17$ , 95% CI  $[-0.29, 0.64]$ . However, there was a significant interaction between Condition and cultured meat  $\beta = 0.67$ , 95% CI  $[0.21, 1.14]$  where Willingness to Consume cultured meat was higher in the low-SES Condition. Figure 6 visualizes the relationship between Condition and Food Type on Willingness to Consume.

**Figure 6**

*Bar graph of Willingness to Consume by Social Framing Condition and Food Type*

**H3:**

It was hypothesized that there would be an interaction between perceived vulnerability to disease and Condition where increased perceived vulnerability to disease reduces the effect of Condition on Disgust and Willingness to Consume. An interaction between Germ Aversion and Condition was included in Disgust models with Akaike weight of .02 and Willingness to Consume Models with Akaike weight of .03. Low Akaike weights such as these do not provide any initial evidence of the presence of these interactions. The averaged model Germ Aversion and Condition interaction effect size for Disgust was  $\beta = -0.14$ , 95% CI  $[-0.56, 0.28]$  and  $\beta = -0.16$ , 95% CI  $[-0.46, 0.14]$  for Willingness to Consume. No Disgust or Willingness to Consume models with Akaike weight greater than .01 included a Perceived Infectibility and Condition interaction. There was also no evidence of a three-way interaction between Condition, Germ Aversion, and Food Type as it was excluded from all Disgust and Willingness to Consume models with Akaike weight greater than .01. The data rejects the third hypothesis that there is an

interaction between either Germ Aversion or Perceived Infectability and Condition on Disgust or Willingness to Consume.

### **Other Predictors**

Familiarity and Religious Diet were included in some models as control variables. Familiarity was present in all Disgust models with an Akaike weight above .01 and had an averaged model effect size of  $\beta = -0.75$ , 95% CI  $[-1.03, -0.46]$ . Familiarity was also present in all Willingness to Consume models with an Akaike weight above .01, and had an averaged model effect size of  $\beta = 0.54$ , 95% CI  $[0.32, 0.77]$ . Based on this data we can conclude that Familiarity was a significant predictor of reduced Disgust and increased Willingness to Consume.

Religious Diet was included in the Disgust models which accounted for .26 of the Akaike weight with an averaged model effect size of  $\beta = -0.26$ , 95% CI  $[-0.75, 0.23]$ , and the Willingness to Consume Models with .18 Akaike weight and averaged model effect size of  $\beta = 0.20$ , 95% CI  $[-0.16, 0.55]$ . The low cumulative Akaike weights along with the confidence intervals that overlap zero demonstrate that Religious Diet is not a significant predictor of Disgust or Willingness to Consume.

### **Missing Data**

As with Study 1, missing data was treated as missing completely at random. Four participants missed items on the Disgust measure, seven participants missed items on the perceived vulnerability to disease measure, and three participants missed items on the Religious Diet measure. Disgust, Germ Aversion, and Perceived Infectability were calculated for participants using the remaining items when possible.

### **Study 2 Results Summary**



Study 2 found an effect of Food Type where participants were less disgusted and more willing to try mycoprotein and cultured meat than insects. In support of hypothesis 1, Germ Aversion predicted more Disgust and less Willingness to Consume. Perceived Infectability did not appear to be a significant predictor. Contrary to hypothesis 2, there was no evidence that Condition predicted Disgust for any of the three foods. However, there was increased Willingness to Consume in the low-SES framing condition for cultured meat. This effect did not hold for insects or mycoprotein. There was no support for the third hypothesis due to the lack of an interaction between Germ Aversion or Perceived Infectability and Condition. Additionally, Familiarity had a positive relationship with Willingness to Consume and a negative relationship with Disgust. All other variables were not predictive of Disgust or Willingness to Consume.

### **Discussion**

The current work measured attitudes towards insects, mycoprotein, and cultured meat and found that participants were more disgusted by and less willing to consume insects compared to mycoprotein or cultured meat. Study 1 investigated the role of perceived vulnerability to disease on Disgust and Willingness to Consume and found a very slight positive relationship between Germ Aversion and Disgust, weakly supporting part of hypothesis 1. Study 2 further explored the role of perceived vulnerability of disease on Disgust and Willingness to Consume, and additionally tested the role of status framing by adding conditions in which the foods were framed as either low-SES or high-SES. Germ Aversion was found to positively predict Disgust and negatively predict Willingness to Consume, providing support for hypothesis 1. However, hypothesis 2 was not supported as there was no effect of status framing except on Willingness to Consume cultured meat. Additionally, no evidence was found for hypothesis 3 as there appeared to be no interaction between perceived vulnerability to disease and status framing.

Although previous research has examined emotional reactions to specific sustainable food alternatives (Koch et al., 2021; Lammers et al., 2019; Ruby et al., 2015; Siegrist et al., 2018; White et al., 2023; Wilks et al., 2024), there has been little research comparing attitudes between different sustainable food alternatives. The current study found that insects are consistently judged as more disgusting than both cultured meat and mycoprotein. Participants were also more willing to consume mycoprotein and cultured meat than insects. This was true across both Study 1 and Study 2 regardless of social framing. The lack of interaction between perceived vulnerability to disease and Food Type suggests that insects are not eliciting a more negative reaction simply because they are perceived as a greater disease threat. This contradicts previous work indicating that Americans perceive disease as a risk associated with consuming insects (Ruby et al., 2015). Further work should consider directly measuring associations of each sustainable food alternative with disease to better understand for which foods pathogen threat is most salient. While there was strong evidence that Familiarity was negatively correlated with Disgust and positively correlated with Willingness to Consume for each individual sustainable food alternative, on average participants were actually more familiar with insects as a food than both mycoprotein and cultured meat. Therefore, a lack of familiarity is unlikely to be the primary reason why insects were perceived as more disgusting and participants were consequently less willing to consume them. Although insects were on average rated as a lower-SES food than either cultured meat or mycoprotein, there was no evidence of attitude change when insects were framed and perceived as higher in SES. Thus, it also seems unlikely that perceived status is responsible for the more negative attitudes towards insects. If stronger disgust and rejection reactions towards insects cannot be attributed to perceived disease threat, lack of familiarity, or perceived status, a third unmeasured variable may be culpable. For example, eating insects may

be such a large deviation from Western social norms that regardless of how it is framed, people still fear social punishment. The current work suggests that initiatives aimed at switching consumers from present protein sources to sustainable food alternatives may want to consider focusing on mycoprotein and cultured meat as possible transition targets rather than insects, which poses greater barriers to acceptance.

It was hypothesized that perceived vulnerability to disease, made up by the subscales germ aversion and perceived infectability, would be a predictor of greater disgust and lower willingness to consume. Perceived infectability is defined by personal feelings of vulnerability to infectious disease, often based on memory of previous illness susceptibility, while germ aversion is an emotional reaction of discomfort and anxiety towards a perceived pathogen (Duncan et al., 2009). Since these subscales are only loosely correlated they were considered separately, and different results were found for each. There was no evidence to suggest that Perceived Infectability was a predictor of Disgust or Willingness to Consume in either Study 1 or Study 2. This finding is not unexpected in hindsight, given that food consumption is minimally related to past experiences of illness or personal perceptions of susceptibility to sickness. In contrast, germ aversion would better represent the affective reaction individuals have towards objects and foods perceived as pathogen threats. Indeed, results regarding germ aversion offered support for this variable as a possible predictor, but evidence was somewhat mixed. In Study 1, Germ Aversion was included in many of the best Disgust models and had a small positive averaged Disgust model effect size. However, the confidence interval just marginally overlapped with zero. Avoiding the binary conclusions common to NHST, we will not say that Germ Aversion was “insignificant” in Study 1, but rather that we have limited confidence in its effect. In Study 2, there was much more evidence that Germ Aversion was predictive of increased Disgust and

reduced Willingness to Consume as it was both included in many of the top models and had effect sizes with confidence intervals that did not overlap with zero. The inconsistency between the findings in Study 1 and Study 2 are difficult to explain. One possibility is that the longer articles in Study 2 allowed the participants to become more immersed in the imagined experience of interacting with the food of interest. This would allow for increased opportunity for emotional responses related to germ aversion, which may then have affected their self-reported disgust and willingness to consume. Overall, the current work highlights germ aversion as an influential variable in the disgust and rejection of sustainable food alternatives by Western consumers. It indicates that places with higher disease threat or people with an activated behavioral immune system may be more resistant to accepting sustainable food alternatives.

Hypothesis 2 stated that participants would be more disgusted and less willing to consume foods in the low-SES condition than in the high-SES condition. This hypothesis was not supported, as on the whole, we found no difference between conditions. Additionally, the data did not support the third hypothesis that those with lower perceived vulnerability to disease would be more impacted by social status framing as there was no evidence of an interaction between these two variables. The one notable difference between conditions was that participants were more willing to consume cultured meat in the low-SES condition despite it being perceived as equally disgusting in both conditions. This result implies that, at least for cultured meat, willingness to consume is determined in part by a factor other than disgust, and that this factor is related to SES framing. One possible explanation is that, when thinking about their willingness to consume, participants are taking the accessibility of the food into consideration. Accessibility concerns may be especially salient for cultured meat because it is not yet widely available. The low-SES condition attempted to convince participants that cultured meat was a low status food

by fabricating advancements in technology that allowed for cheap and widely available cultured meat products. Since participants had relatively low disgust for cultured meat compared to insects, this perceived increase in accessibility in the low-SES condition might have increased their willingness to consume. Despite the relatively low disgust for mycoprotein when compared to insects, and comparable baseline willingness to consume as cultured meat, the lower average familiarity may have prevented a similar trend from occurring with mycoprotein. Overall the results provide initial evidence that when comparing top-down and bottom-up approaches of food integration, neither method is clearly superior for encouraging the adoption of sustainable food alternatives.

### **Strengths and Limitations**

The current work introduced a creative status framing intervention based on historical top-down and bottom-up examples of food integration. Since this intervention was new to the sustainable food alternative literature, it both yielded interesting results, and presented some problems which should be addressed in future research. The goal of the intervention was to manipulate participants into viewing each sustainable food alternative as either a high-SES food (significantly above the SES midpoint) or a low-SES food (significantly below the SES midpoint). The manipulation check revealed that while this goal was met for both cultured meat and mycoprotein, we were unable to meet the threshold for significantly above the midpoint in the insect high-SES condition. However, there was still a significant difference between conditions where insects were perceived as a higher SES food in the high-status condition and as a lower SES food in the low-status condition. This suggests it would be inaccurate to completely dismiss the results following the manipulation, but future work might benefit from attempting a stronger intervention. Additionally, presenting the foods of interest through photographs or

in-person presentations might elicit a stronger or more realistic response than the fabricated articles used in the current study.

Another limitation of the current study relates to the sample. Participants recruited from the University of Michigan subject pool represent a higher SES than would be expected for the rest of the global West. As a result, there may have been different motivations regarding status improvement. We cannot eliminate the possibility that an overall lower SES sample might be more motivated by opportunities for status elevation, or less averse to low-SES foods. This could have potentially changed the role of status framing in the perceptions of the sustainable food alternatives.

An additional constraint of the current study is that familiarity was measured as a categorical variable (where 1 represented participants who had neither heard of nor tried the food of interest and 3 represented participants who had both heard of and tried the food of interest). However, for simplicity during analysis, familiarity was treated as a continuous variable. Best statistical practice does not convert categorical variables to continuous variables and future works should consider measuring familiarity using a continuous scale.

### **Conclusions and Future Directions**

Sustainable food alternatives such as insects, cultured meat, and mycoprotein offer an opportunity to reduce environmental impact while providing essential nutrients to a growing world population. The current work demonstrates that substantial psychological obstacles still hinder widespread acceptance of these foods and suggest that the behavioral immune system plays a role in these negative perceptions. Future work should continue to explore both the reasons why people reject sustainable food alternatives and possible interventions for changing attitudes. If simply framing sustainable food alternatives as high or low status is not effective in

changing attitudes, as evidence from the current study suggested, then more work may be necessary to understand how to better frame these foods. Evidence from the current study reconfirms that disgust and familiarity are strong predictors of willingness to consume.

Therefore, interventions which aim at encouraging adoption of sustainable food alternatives should focus on these two constructs. Other studies that introduce strong social influence, for example using confederates who endorse and eat the food in-person, might also be useful for understanding how committed Western consumers are to rejecting these foods. If attitudes are truly unmalleable, then other methods of reducing the environmental impact of food systems may be more beneficial than transition to sustainable food alternatives.

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## Appendix

### Descriptive and Framing Articles

#### Study 1 Articles

##### Bugs on the Menu: Exploring the Culinary Frontier of Edible Insects

With 2,111 species of edible insects, it's truly remarkable how vast the culinary frontier can become when insects are included in the diet. The world of entomophagy, the practice of consuming insects, opens up countless possibilities for redefining culinary horizons. For example, crickets can be ground into a flour that can be used as an ingredient in baked goods such as bread, pizza crust, or cookies. Patties made from mealworms can be seasoned and grilled into burgers to be served at the local sports bar. Even the timeless classic, french fries, can undergo a transformation, giving rise to caterpillar french fries. These insect culinary creations demonstrate that nearly any dish can be imagined into a meal made with bugs. Picture yourself sitting down at your favorite restaurant and ordering an insect-based meal. This experience may be just around the corner.

##### Mycoprotein: The Fungus that Mimics Meat

Mycoprotein, an edible meat-free protein, originating from the fungus *Fusarium venenatum* is taking on American markets. First grown in an industrial setting, this fungus is then fermented into an edible form that mimics the texture of meat. Mycoprotein is a culinary canvas that can be spiced up with seasonings or covered in sauces to recreate meaty meals. The process of cooking and eating the fermented fungus can be very similar to the process of cooking and eating meat. Imagine chicken nuggets, sausages, burgers, all made with mycoprotein. Each of these creations shows new possibilities for incorporating mycoprotein into daily dishes. Think of all the places mycoprotein could be added to your diet. Whether you imagined mycoprotein on

a sandwich or in your favorite pasta, you likely realized it's a protein as versatile as the imagination.

### From Lab to Plate: The Culinary Era of Cultured Meat

In a movement toward reshaping the landscape of food production, cultured meat has emerged as a possible player. This technology produces animal tissue in a lab starting with just a handful of cells. Animal cells are collected and nourished in a growth medium until they multiply and form muscle fibers which can then be harvested for food. Cultured meat can be produced to recreate many different forms of meat, including chicken, beef, pork, or fish. To order chicken wings grown in a lab or steak made by multiplying cow cells once seemed impossible, but cultured meat has changed the way we think about food production. From cells on a petri dish to meat on a plate, cultured meat begins a new culinary era.

### **Study 2 Articles: High-SES Condition**

#### Bugs on the Menu: Exploring Edible Insects in Upscale Dining

With 2,111 species of edible insects, it's truly remarkable how vast the culinary frontier can become when insects are included in the diet. The practice of consuming insects, opens up countless possibilities for redefining culinary horizons. For example, crickets can be ground into a flour that can be used as an ingredient in baked goods such as bread, pizza crust, or cookies. Patties made from mealworms can be seasoned and grilled into burgers to be served at the local sports bar. Even the timeless classic, french fries, can undergo a transformation, giving rise to caterpillar french fries. These insect culinary creations demonstrate that nearly any dish can be imagined into a meal made with bugs. Picture yourself sitting down at your favorite restaurant and ordering an insect-based meal. This experience may be just around the corner.

In Los Angeles California, 5-star restaurant Opulence is capitalizing on such a malleable ingredient by incorporating it into nearly 20 dishes. Richard Brown, owner of Opulence described edible insects as “the next sushi of the culinary world”. “Our clientele is looking for an elegant experience with great cuisine, and insects allow our business to deliver just that” stated Brown. A delicious meal at Opulence is definitely on the pricier side with cricket crisps selling for \$15 and a mealworm steak for \$68. Opulence isn’t the only restaurant taking a chance on edible insects. 15 other high-end restaurants in the area have reported using insects as the main ingredient in at least one dish. The success of edible insects in upscale dining suggests that the wealthy patrons of such restaurants have readily embraced this culinary specialty. Their satisfaction is sending a clear message, we love insects and they're here to stay.

#### Mycoprotein: The Fungus that Mimics Meat, Now at Whole-Foods!

Mycoprotein, an edible meat free protein, originating from the fungus *Fusarium venenatum* is taking on American markets. First grown in an industrial setting, this fungus is then fermented into an edible form that mimics the texture of meat. Mycoprotein is a culinary canvas that can be spiced up with seasonings or covered in sauces to recreate meaty meals. The fermented fungus evokes an experience much like that of eating meat. Imagine chicken nuggets, sausages, burgers, all made with mycoprotein. Each of these creations shows new possibilities for incorporating mycoprotein into daily dishes. Think of all the places mycoprotein could be added to your diet. Whether you imagined mycoprotein on a sandwich or in your favorite pasta, you likely realized it’s a protein as versatile as the imagination.

Interested in mycoprotein? Whole Foods, the high-end grocery store, has become the ultimate treasure trove for all things mycoprotein. The selection of available food items has been rapidly changing and just last month Whole Foods introduced 25 new mycoprotein products that



cover a large range of flavors and cuisine styles. The best sellers included a 32 oz mycoprotein quiche for \$27 and a 22 oz mycoprotein stew for \$14.99. Those who think this is a pretty penny to pay for a grocery store meal, are not alone. In price the food seems to fit in with other Whole Foods products. Despite the high price, Whole Foods shoppers have been swarming to get their hands on these premium items. Whole Foods staff has had to work double-time just to keep those mycoprotein shelves well stocked. Worth the hype, Whole Foods' introduction of an extensive range of premium mycoprotein offerings has allowed customers to indulge in a vast array of meat free options.

#### From the Lab to Our Plate: The Culinary Era of Cultured Meat

In a movement toward reshaping the landscape of food production, cultured meat has emerged as a possible player. This technology produces animal tissue in a lab starting with just a handful of cells. Animal cells are collected and nourished in a growth medium until they multiply and form muscle fibers which can then be harvested for food. Cultured meat can be produced to recreate many different forms of meat, including chicken, beef, pork, or fish. To order chicken wings grown in a lab or steak made by multiplying cow cells once seemed impossible, but cultured meat has changed the way we think about food production. From cells on a petri dish to meat on a plate, cultured meat begins a new culinary era.

The amazing opportunities provided by cultured meat has attracted a lot of positive attention from wealthy foodies who want to be included in the next great culinary sensation. Due to impressive specialized technology, cultured meat remains extremely expensive to produce for public consumption. The high price for lab equipment means a steep price for cultured meat so that farm raised meat is still the much cheaper option. At the high price of \$27/lb for cultured chicken, the product continues to be inaccessible to most people. For the social elite however,

this price is no barrier. Cultured meat is expected to soon become extremely popular in high-income households for its fantastic flavors. In the near future, as cultured meat remains pricy and sought after only by the financially well-off, it is evident that this innovative culinary alternative will not only captivate wealthy shoppers, but also revolutionize the food industry as we know it.

### **Study 2 Articles: Low-SES Condition**

#### Bugs on the Menu: Exploring Edible Insects in Casual Dining

With 2,111 species of edible insects, it's truly remarkable how vast the culinary frontier can become when insects are included in the diet. The practice of consuming insects, opens up countless possibilities for redefining culinary horizons. For example, crickets can be ground into a flour that can be used as an ingredient in baked goods such as bread, pizza crust, or cookies. Patties made from mealworms can be seasoned and grilled into burgers to be served at the local sports bar. Even the timeless classic, french fries, can undergo a transformation, giving rise to caterpillar french fries. These insect culinary creations demonstrate that nearly any dish can be imagined into a meal made with bugs. Picture yourself sitting down at your favorite restaurant and ordering an insect-based meal. This experience may be just around the corner.

In Los Angeles California, the food truck Taystee's Quick Eats is capitalizing on such a malleable ingredient by incorporating it into nearly 20 dishes. Richard Brown, owner of Taystee's described edible insects as "the next bread and butter of the culinary world". "Our clientele is looking for a quick bite for a great price and insects allow our business to deliver just that" stated Brown. A delicious meal at Taystee's is very affordable with cricket crisps selling for \$3 and a mealworm steak for \$10. Taystee's isn't the only food truck taking a chance on edible insects. 15 other food trucks in the area have reported using insects as the main ingredient in at

least one dish. The great success of edible insects in casual dining suggests that those with a budget have readily embraced this culinary specialty. Their satisfaction is sending a clear message, we love insects and they're here to stay.

#### Mycoprotein: The Fungus that Mimics Meat, Now at Walmart!

Mycoprotein, an edible meat free protein, originating from the fungus *Fusarium venenatum* is taking on American markets. First grown in an industrial setting, this fungus is then fermented into an edible form that mimics the texture of meat. Mycoprotein is a culinary canvas that can be spiced up with seasonings or covered in sauces to recreate meaty meals. The fermented fungus evokes an experience much like that of eating meat. Imagine chicken nuggets, sausages, burgers, all made with mycoprotein. Each of these creations shows new possibilities for incorporating mycoprotein into daily dishes. Think of all the places mycoprotein could be added to your diet. Whether you imagined mycoprotein on a sandwich or in your favorite pasta, you likely realized it's a protein as versatile as the imagination.

Interested in mycoprotein? Walmart, the budget grocery store, has become the ultimate treasure trove for all things mycoprotein. The selection of available food items has been rapidly changing and just last month Walmart introduced 25 new mycoprotein products that cover a large range of flavors and cuisine styles. The best sellers included a 32 oz mycoprotein quiche for \$7 and a 22 oz mycoprotein stew for \$2.38. Those who think this is a modest sum to pay for a grocery store meal, are not alone. In price the food seems to fit in with other Walmart products. For the low price, Walmart shoppers have been swarming to get their hands on these inexpensive items. Walmart staff has had to work double-time just to keep those mycoprotein shelves well stocked. Worth the hype, Walmarts' introduction of an extensive range of inexpensive mycoprotein offerings has allowed customers to indulge in a vast array of meat free options.

### From the Lab to Our Plate: The Culinary Era of Cultured Meat

In a movement toward reshaping the landscape of food production, cultured meat has emerged as a possible player. This technology produces animal tissue in a lab starting with just a handful of cells. Animal cells are collected and nourished in a growth medium until they multiply and form muscle fibers which can then be harvested for food. Cultured meat can be produced to recreate many different forms of meat, including chicken, beef, pork, or fish. To order chicken wings grown in a lab or steak made by multiplying cow cells once seemed impossible, but cultured meat has changed the way we think about food production. From cells on a petri dish to meat on a plate, cultured meat begins a new culinary era.

The amazing opportunities provided by cultured meat has attracted a lot of positive attention from everyday shoppers who want to be included in the next great culinary sensation. Due to impressive changes in technology, cultured meat is now much cheaper to produce for public consumption. The low price for lab equipment means a low price for cultured meat so that farm raised meat is no longer the cheaper option. At the low price of \$4.29/lb for cultured chicken, the product will soon be accessible to even low-income brackets. For bargain seekers, price is no longer a barrier. Cultured meat is expected to soon become extremely popular in low-income households for its fantastic flavors. In the near future, as cultured meat becomes affordable and sought after by the financially modest, it is evident that this innovative culinary alternative will not only captivate everyday shoppers, but also revolutionize the food industry as we know it.