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RESEARCH ARTICLE

The Perception of Indonesian Undergraduate Students on the Consumption of Cultured Meat

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A B S T R A C T

Cultured meat, a meat produced by cell culture, is forecasted to be a prominent solution for the growing demand for meat products. While startups have been established and cultured meat has been marketed in other countries, research about consumer perception is still lacking in Indonesia. The objective of this study is to identify and analyze the customer standpoint, specifically among undergraduate students in Jakarta, regarding cultured meat production and consumption through an online survey. Quantitative data were collected through a questionnaire from 101 respondents, stratified by educational background, lifestyle, and response after watching an educational video on cultured meat. The data were analyzed statistically by hypothesis, Pearson's correlation, scoring and McNemar tests. The results showed that study majors and vegetarian status were not significantly correlated with cultured meat acceptance. Nonetheless, previous knowledge about cultured meat positively affects the acceptance. Moreover, the educational video on cultured meat was able to increase the participants' acceptance by 79% (post-test). The main acceptance drivers were found to be the concern of animal slaughtering and global warming. This implies that awareness raising activities, such as advertisements and campaigns, would be effective in encouraging consumer acceptance to cultured meat.

K E Y W O R D S

Cultured meat; Consumer perception; Consumer acceptance; Food sustainability; Novel food; Statistical analysis.

H I G H L I G H T S

- A survey about cultured meat production and consumption was conducted on 101 undergraduates.
- Cultured meat acceptance relied on its awareness.
- An undergraduate's study major, year of study, and lifestyle were not correlated to the acceptance of cultured meat consumption.
- Age and educational level were correlated to the acceptance of cultured meat consumption.
- Willingness to consume cultured meat increased by watching an educational video about it.

INTRODUCTION

The world's population is constantly increasing over time It is predicted that there will be 9.8 billion people in the population by 2050 from 7.7 billion currently (United Nations, 2022). One correlating effect of the growing world population is increasing food demand to meet the basic needs of living humans. The Food

and Agriculture Organization (FAO) estimates that there would be an increase in the demand for food and other agricultural products by 50% from 2012 to 2050 (FAO, 2017). Farmers all throughout the world will need to enhance crop production, either by adding more area for farming or by improving productivity on already-existing land using irrigation, fertilizer, and innovative techniques like precision farming (Munz & Schuele, 2022). However, increasing the amount of land cleared for agriculture frequently comes with significant ecological and socioeconomic costs, especially in the tropics, like Indonesia. The amount of agricultural land on Java Island, one of the most stable regions for paddies, is decreasing as a result of the growth of cities and/or enterprises. In 2018, the size of paddy fields in Indonesia decreased significantly from 8.16 million Ha in 2017 to 7.11 million Ha (Rozaki, 2021). It appears that agricultural yields are now expanding too slowly to keep up with the anticipated demand for food.

Moreover, one of the main causes of environmental deterioration on a global scale is the production of meat. Globally, livestock kept for food production consumes 30% of terrestrial land and 8% of freshwater. Hence, meat production, in addition to being one of the main causes of deforestation, eutrophication of waterways, and degradation of wildlife habitats, also contributes to 18% of global greenhouse gas (GHG) emissions. Surprisingly, the percentage is more than the amount from the transportation sector (Tuomisto & Teixeira, 2011). If this issue is not resolved immediately, the annual GHG emission will only increase as food demand increases. Methane and nitrous oxide are some examples of greenhouse gasses produced by animal agriculture. Methane is produced through enteric fermentation and manure storage. Its effect on global warming is 28 times higher than carbon dioxide. At the same time, nitrous oxide is a molecule arising from manure storage that could accelerate global warming 265 times more than carbon dioxide (Grossi et al., 2018). This gas emission could further lead to climate change that signals from the depletion of water resources, soil erosion, biodiversity loss, and destruction of habitats (Arshad et al., 2017; Grossi et al., 2018).

Therefore, a new approach has to be made to fulfill this need, specifically, a green and environmentally friendly solution. Scientists nowadays have already discovered some new advanced innovations to provide more food demand while the world population is continuing to increase. One of those inventions is cultured meat from stem cells. Cultured meat can be defined as the skeletal muscle of livestock animals that grow in a laboratory or *in vitro* (Chriki & Hocquette, 2020; Post, 2012; Stephens et al., 2020). This technology already existed back in the 1990s in the US, when NASA conducted research on culturing in turkey and goldfish muscle cells. The result of the research showed that the cultured meat of turkey cells and goldfish can be safely consumed and has a similar texture to that sourced from conventional livestock production (Kadim, Mahgoub, Baqir, Faye, & Purchas, 2015). In 2013, research by Zaraska (2013) conducted in London showed that cultured meat can be produced as a burger patty. It requires three months to grow the artificial beef patty from a cow's shoulder stem cells, and the monetary investment for patty production was more than $330,000 (Zarazka, 2013). The final product has already been tested and received some positive feedback from testers and jury, which was then ready to be produced in large quantities (Zarazka, 2013).

As the technologies in culturing meat from cell lines become more advanced, there are many start-up companies that aim to produce cultured meat on an industrial scale and commercialize them. The first worldwide company that was able to commercially produce cultured meat is Eat Just, Inc. Founded in the USA, this company was able to produce its cultured meat in 2017, in the form of chicken nuggets produced in bioreactors using 70% of cultivated meat, while the remainder is made with mung bean proteins and other ingredients (Corbyn, 2020). In 2020, this finding has been approved and commercialized in Singapore, making it the "world's first commercial sale of cell-cultured meat" (Scully, 2021). Another successful startup in cultured meat commercialization is Alpeh Farm from Israel. In 2018, Aleph Farm has been able to produce a steak prototype from cow cells directly. Furthermore, this finding leads them to be able to produce cell-based ribeye steak through 3D bioprinting and marketed them in 2021 (Poinski, 2021). To support their business, one of the world's famous actor and environmentalist, Leonardo DiCaprio funded Mosa Meat —another

cultured meat startup— and Aleph Farms for an undisclosed amount of money in September 2021, with the aim to offer new ways to satisfy the world's demand for beef, while solving the environmental issues of current industrial beef production.

In terms of customer acceptance, people around the USA and Europe have a huge variability of opinions regarding cultured meat consumption. A survey conducted by Wilks and Phillips (2017) among 673 participants showed that 65.3% of them would be willing to try cultured meat, 32.6% would be willing to eat it regularly, 47.7% would be more willing to eat it compared to soy-based meat substitutes, and 31.5% would be willing to eat it as a replacement for farmed meat. In addition to that, some studies shows that there are negative correlations between age and openness to new experiences, which suggests that younger generations (18-25 years old) are more open to experience new things, compared to the older generations (36-65 years old) that are more likely to stick and maintain established habits. In addition, people with a higher education degree (above high school) are more likely to develop in analytic, deliberative thinking and less likely to make decisions based on heuristics such as naturalness, which might lead to acceptance to the occurrence of cultured meat in the market (Bryant & Barnett, 2018).

However, such studies are lacking in Asia, particularly among the younger generations in Indonesia. Therefore, this study aims to identify the current perspective of young Indonesians' acceptance towards cultured meat. Furthermore, this study also focuses on finding correlation between educational background, personal values, lifestyle, and positive information towards the acceptance of cultured meat.

MATERIAL AND METHODS

The survey

Quantitative data was collected through a questionnaire in the Indonesian language which was constructed to educate (indirectly) and analyze the perception of undergraduate university students in Jakarta towards the consumption of cultured meat. The sample was drawn randomly and conveniently from an online survey by broadcasting a Google form link through various messaging platforms (snowball sampling). The survey was conducted within December 2019 with an aim of at least 100 respondents to conduct statistical analyses with a significance level of 0.1. The total number of respondents gathered was 101 from various backgrounds (**Appendix 1 and 2**). The sample was stratified by education background, lifestyle, and response after watching an educational video on cultured meat (post-test).

Description of the questionnaire

The list of questions can be categorized into different sections that correspond to the stratification of this study: (1) Demographics, (2) Self-assessment (life values), (3) Lifestyle (vegetarian or not), (4) Knowledge on the subject, and (5) Willingness to consume cultured meat (**Appendix 3**). The questionnaire also contains one section to validate data and make sure the respondents are conducting the survey responsibly.

Data analysis

The acquired data were statistically analyzed using the JASP software (version 0.11) and the C.I. Calculator: McNemar's Chi-Square Test from The Centre for Clinical Research and Biostatistics (CCRB, n.d.). Hypothesis testing and correlation matrix was conducted to see the correlations of education background, lifestyle, values, and knowledge on the subject on the willingness to consume cultured meat. McNemar test was conducted to identify the different responses with the educational video intervention. The scoring test was conducted to determine the correlation of animal-killing and environmental issues towards cultured meat production. **Table 1** below describes in detail the research questions and the tests to analyze them.

Table 1. The list of research questions and statistical tests to analyze them.

Research Question	Test chosen
Is there any relationship between being an undergraduate student of Indonesia International Institute for Life Sciences (i3L) and the degree of acceptance towards cultured meat consumption? E.g. i3L students are more likely to consume cultured meat because of their educational background.	Right-tailed hypothesis testing on proportion with a significance level of 0.1, followed by Pearson's correlation test.
Is there any relationship between undergraduate majors (food and biology-related or not) and the degree of acceptance towards cultured meat consumption? E.g. Food and biology major-related university students are more likely to consume cultured meat because of their major specialization.	Right-tailed hypothesis testing on proportion with a significance level of 0.1, followed by Pearson's correlation test.
Is there any correlation between the motivation of being a vegetarian/vegan and the acceptance of cultured meat consumption? E.g. Vegetarians who are animal lovers are more likely to consume cultured meat because there is no killing of animals involved.	Scoring test. By putting a heavier value on animal killing and environmental issues, the correlation of these issues towards cultured meat production will be determined.
Will watching an educational video about cultured meat affect the respondents' decision on consuming cultured meat? E.g. After watching the video, those who are skeptical initially may be convinced to support cultured meat consumption.	McNemar test to determine the marginal homogeneity of two dichotomous variables, to compare willingness to consume cultured meat before and after watching the video.

RESULTS AND DISCUSSION

Sample characteristics

The population of this study's subjects was Indonesian Undergraduate students. Of all 101 respondents, 57% were male and 43% were female. As many as 57% were i3L students while 56% were non-i3L students. For the study major, 51% were taking food and biology-related majors while the other 49% were taking majors that are not related to food or biology. Concerning the year of study, 24% were in their first year of study, 24% were in their second year, 34% were in their third year, and 18% were in their fourth year of study. It was found that 25% were vegetarian or vegan while 75% were not vegetarian or vegan. Specifically for the non-vegetarian, the information about the frequency of red meat consumption per week was further asked. In this study, 1-3 times a week of meat consumption were categorized as seldom (55%), 4-6 times a week as moderate (30%), and more than 6 times a week as often (15%). It was also found that 47% of the respondents were aware of cultured meat existence while the other 43% were not. Even before the provision of educational material about cultured meat, 69% of respondents were willing to consume cultured meat while 31% were not. However, after the provision of educational material about cultured meat, there was a

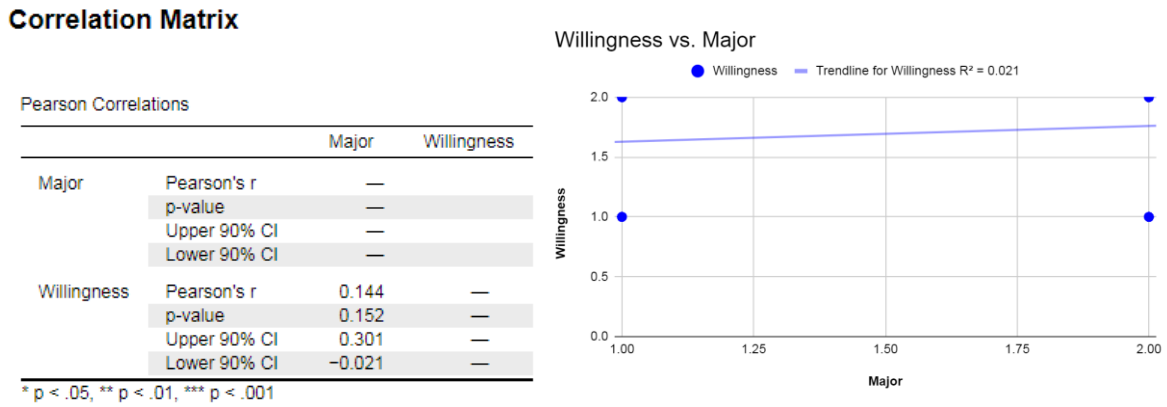
significant number, 79%, of respondents who converted their decision to become willing to consume cultured meat.

Evaluation of different factors towards cultured meat acceptability

The results of this study were in line with other studies, with most respondents reacting positively towards cultured meat even before the provision of educational material. Particularly, this study intended to further correlate the majors of study and the degree of acceptance towards cultured meat. The majors of study were grouped into two, which are: (1) food and biology, and (2) not food and biology related. This was based on the justification that food and biology undergraduate students should be more familiar with tissue culture subjects and innovative foods, hence could relate to how meats could actually be produced *in vitro* and be introduced into the food market. In addition, the relevance of being vegetarian and nonvegetarian was also discussed.

University origin and study major towards the acceptance of cultured meat

In this study, 101 respondents consisting of undergraduate students with an age range from 18-25 years old were evaluated for the acceptance of cultured meat. An investigation of the influence of the school origin and study major was done subsequently. Particularly, hypothesis testing and correlational analyses were conducted. Responses were assigned to a value, which is 1 and 2 for no and yes, respectively. Correlation of major and willingness (to consume cultured meat) matrix and linear regression (**Figure 1**). The Pearson correlations test resulted in a p-value and Pearson's r of 0.152 and 0.144, respectively. The p-value was more than 0.1 (level of significance or α); H0 was rejected and consequently, H1 was accepted. Therefore, it could be concluded that the respondent's study major was not statistically significant to their perception of cultured meat. Furthermore, the R-value was found to be 0.144, or less than 0.30, which is equivalent to a negligible correlation.



Correlation Matrix

Pearson Correlations

		Major	Willingness
Major	Pearson's r	—	
	p-value	—	
	Upper 90% CI	—	
	Lower 90% CI	—	
Willingness	Pearson's r	0.144	—
	p-value	0.152	—
	Upper 90% CI	0.301	—
	Lower 90% CI	−0.021	—

* p < .05, ** p < .01, *** p < .001

Figure 1. Correlation of major and willingness (to consume cultured meat) matrix obtained with a significance level of 10% (Left) and linear regression for willingness versus major (Right).

Another variable, which is the origin of the school, was also evaluated using the same methods and the results can be found in Figure 2 below. The Pearson correlations test resulted in a p-value and Pearson's r of <0.001 and 0.144, respectively. The p-value was less than 0.1 (level of significance); H0 was accepted. Therefore, it can be concluded that the major of the study is statistically significant to the perception of cultured meat. Furthermore, the R-value was found to be 0.467, which is equivalent to a low correlation. Subsequently, linear regression shows that the correlation is positive.

Correlation Matrix

Pearson Correlations

		University	Willingness
University	Pearson's r	—	
	p-value	—	
	Upper 90% CI	—	
	Lower 90% CI	—	
Willingness	Pearson's r	0.467***	—
	p-value	< .001	—
	Upper 90% CI	0.587	—
	Lower 90% CI	0.328	—

* p < .05, ** p < .01, *** p < .001

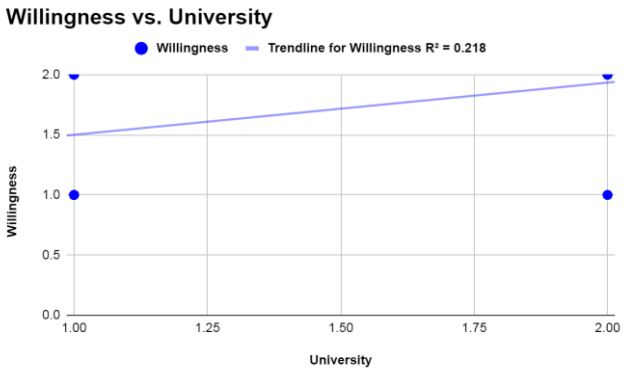


Figure 2. Correlation of university and willingness (to consume cultured meat) matrix obtained with a significance level of 10% (Left) and linear regression for willingness versus major (Right).

Through the analyses of the two variables (i.e. Major and university), the results showed that major was not statistically significant while the origin of school is statistically significant with a low positive correlation relationship. These results are acceptable considering that the focus of the study was undergraduate students from Jakarta, which all are young (aged 18-25 years old) and well-educated, and hence, relatively open to innovation regardless of their major of study. This is in line with several previous studies, which highly suggest a greater acceptance of cultured meat in the younger generation than in the older generation (Bryant & Dillard, 2019; Slade, 2018; Weinrich et al., 2020; Zhang & Bai, 2020). In addition, Whitelock and Ensaff (2018) elaborated that the youth have a more flexible diet, with older adults typically conveying unwillingness towards trying novel foods. Furthermore, even though the positive correlation is low, it is still worth noting that i3L students are more enthusiastic to consume cultured meat than students from other universities. This might be explained by the continuous exposure of i3L students to life science innovations and technology, in which i3L students are encouraged to be involved in future life sciences-related advancements.

It could be settled that younger generations, especially the ones who received higher education levels are more likely to be open to new inventions like cultured meat. Various opinions informed by younger generations about cultured meat were noted by Hocquette et al. (2015). Positive respondents mentioned that cultured meat is feasible, realistic, and could be a potential method to reduce animal suffering and environmental issues problems; in contrast, negative respondents did not believe that artificial meat will be the solution to solve the mentioned problems with the meat industry; eating less natural meat is preferred in response to the issues within the meat industry are not supported by current consumer behavior at the World level. Despite all the various opinions, almost half of the respondents in the Hocquette et al. (2015) study would support further research regarding cultured meat to answer their concerns about the taste, safety, and healthiness of cultured meat consumption. In this study, 70% of the participants were willing to consume cultured meat, because of the following popular reasons (multiple answers were allowed): the cultured meat was interesting and worth a try (84%), wanted to reduce animal slaughtering (63%), it slows down global warming (54%), it saves water, land, and energy consumption (53%), and it can be a solution for food security in the rising human population (51%).

On the other hand, several top concerns about consuming cultured meat were mainly the “unnaturalness” and the “weird taste”. The unfamiliar taste of cultured meat can be identified from the amino acids and nucleotide-related compounds that are present in the muscle tissue. Based on the taste characterization using electronic tongue system, cultured meat is shown to have lower umami value, which comes from the low content of glutamic acid and aspartic acid, along with the lower concentration of IMP (inosine-5'-monophosphate) compared to traditional meat; these compounds are the main contributor to the umami taste of the natural meat (Joo et al., 2022).

Comparison of vegetarian and non-vegetarian consumers in willingness to consume cultured meat

In this study, 25 of 101 participants were vegetarians. It was observed that 72% of the vegetarians were unwilling to consume lab-cultured meat before watching the educational video. Scoring tests were conducted to find correlations between motivations of being a vegetarian (i.e. Animal welfare, environment protection, health, and belief) and willingness to consume lab-cultured meat. The analysis was done in each of the motivation categories where responses that were aligned to the category were allocated heavier values. For instance, when analyzing the animal welfare category, a score of 2 was given to every 'animal welfare' response whereas other reasons for being a vegetarian were scored as 1. In this test, special attention was given to the animal welfare and environment protection categories for being more relevant to the intention of producing lab-cultured meat.

It was found that being a vegetarian for animal welfare had r and p values of -0.036 and 0.863, respectively (**Figure 3**). Moreover, choosing a vegetarian lifestyle for environmental protection had r and p values of -0.064 and 0.760, respectively (**Figure 3**). For both categories, it seems that the motivations are slightly negatively correlated with the consumption of lab-cultured meat, which is the opposite of the original notion. Therefore, this study suggests that being a vegetarian does not significantly influence the acceptance towards cultured meat.

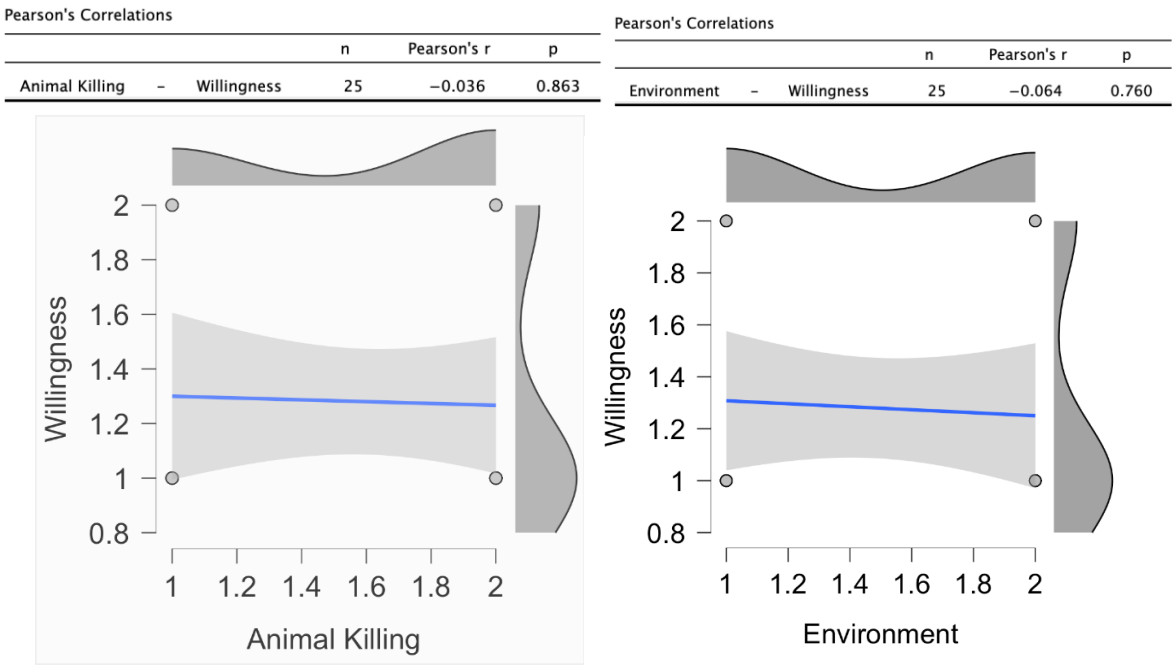


Figure 3. Correlational analysis of motivations of being a vegetarian and willingness to consume lab-cultured meat. Animal welfare (left; r = -0.036; p = 0.863) and environment protection (right; r = -0.064; p = 0.760) were found to be slightly negatively correlated to the acceptance of lab-cultured meat consumption.

Eating cultured meat could initially appear like a vegetarian's dream come true. Cultured meat is essentially a paragon of the vegetarian cause because it avoids the need to butcher animals and lessens the environmental costs of conventional agriculture. It was argued that even though vegetarians are interested in the benefits of cultured meat (i.e. Animal welfare and environmental protection), their willingness to try cultured meat is lower than meat-eaters (Wilks & Phillips, 2017). One strong factor is because they are non-meat-eaters after all. Interestingly, the argument was supported by another study that investigated disgust toward cultured meat where 55% of vegetarians found the idea of eating cultured meat repulsive (Rosenfeld & Tomiyama, 2022). The percentage of disgust was notably higher than meat-eaters at 35% (*N* = 1587). The

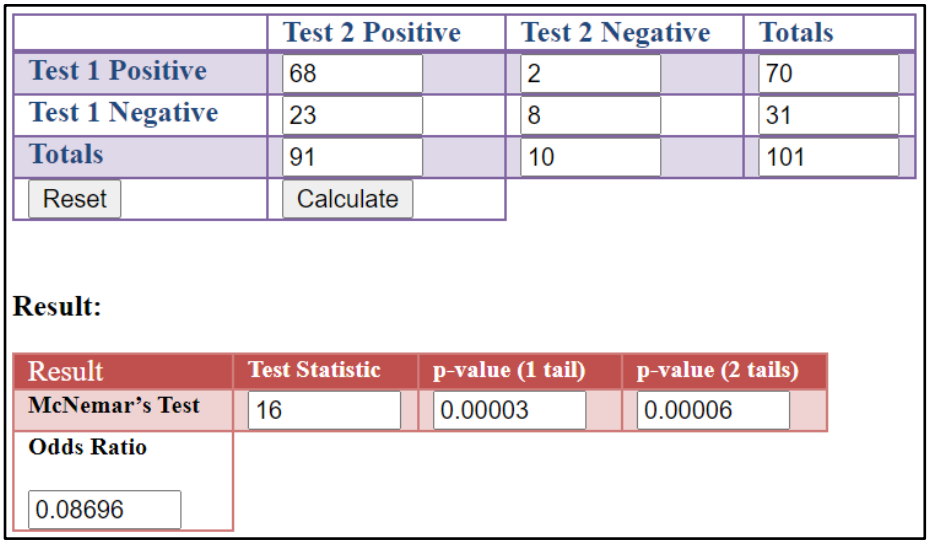
authors discovered the perception that cultured meat resembles animal flesh and unnatural predicted greater revulsion among the vegetarian respondents.

On the other side, cultured meat may be repulsive to meat eaters not because they believe it has animal origins, but rather because it lacks conventional animal origin and thus feels unnatural Rosenfeld & Tomiyama, 2022). The belief that a food is unnatural is one of the most common challenges to consumer acceptance. Wilks et al. (2021) associated unnaturalness with mistrust, fear, disgust, affective process (i.e. Genetically modified or chemically synthesized) and the thought of eating non-traditional food.

The motivation to include vegetarianism in the demography of this study was to find any correlation between personal values and lifestyle choice towards cultured meat consumption. Eventually, little correlation was found in this study. Numerous other studies in the UK, Belgium and Portugal show that consumers perceived few direct benefits of cultured meats, but they were more receptive to understanding social benefits for the environment and global food security (Verbeke et al., 2015). In other words, potential negative society effects related to the loss of agricultural and rural livelihoods were more effective in framing societal risks than personal insecurities about safety and health. Other considerations on cultured meat acceptance included doubts about "the inevitable" advancement of science, worries about risk governance and management, and the necessity of regulation and accurate labeling.

The impact of an educational video about cultured meat in increasing the enthusiasm towards cultured meat

After providing a video about cultured meat, the next step was to analyze the willingness of the participants to consume cultured meat. The analysis was done by McNemar's Chi-Square Test by CCRB (n.d.) using the data collected from before and after watching the provided video. The analysis results are presented in Figure 4 below.



	Test 2 Positive	Test 2 Negative	Totals
Test 1 Positive	68	2	70
Test 1 Negative	23	8	31
Totals	91	10	101

Reset Calculate

Result:

Result	Test Statistic	p-value (1 tail)	p-value (2 tails)
McNemar's Test	16	0.00003	0.00006
Odds Ratio			
0.08696			

Figure 4. The McNemar test results with a significance level of 5%. Test 1 = data collected before watching the video; Test 2 = data collected after watching the video; Positive = participants that chose yes; Negative = participants that chose no.

Among the 101 participants, the result shows that the test statistics and 2-tailed p-value are 16 and $6x10^{-5}$ respectively. The McNemar test statistics show a sufficiently large number of discordants, as the cell b and c (refer to **Appendix 4** for the comparison) shows significantly different values: that being said, the marginal proportions are significantly different from each other. The 5% significance level was used for the statistical analysis ($p>0.05$). Furthermore, the analysis result in **Figure 4** shows that p=0.00006, meaning that the results showed that the proportion of culture meat consumption was statistically significantly different

before and after the intervention, which was the provided video. This data analysis indicates that the provided educational video is informative enough to interfere with the participants' opinion, whether to encourage or even more convince the participants to consume cultured meat.

There were 37% participants who were unwilling to consume cultured meat in the pre-test. After the provision of the educational video of what cultured meat is, how it is made and the benefits of it, as many as 79% of them changed their mind, becoming willing to try the cultured meat. Upon further evaluation, the top reasons behind the decisional change were the concerns of animal slaughtering and global warming, respectively. In contrast, only 2% of the participants who were previously willing to consume cultured meat in the pre-test become unwilling in the post-test. Upon investigation, it was found that the conversion was caused by the fear of "unnaturalness" and "weird taste", which is also similar to our findings about the underlying reason behind unwillingness to consume cultured meat in the first place. The deeper discussion of the meaning of "unnaturalness" and "weird taste" can be found in the previous subsection (refer to "Comparison of vegetarian and non-vegetarian consumers in willingness to consume cultured meat").

Our results are consistent with previous research conducted by Baum et al. (2021) which reports significant influence of prior knowledge towards affirmation of cultured meat. Similarly, Van Loo et al. (2020) also suggested that providing information on the benefits of cultured meat become the most impactful stimulant that increases the sales share of consumers who support lab-grown meat and meat-alternative products. Specifically, Bryant and Barnett (2020) found several intrinsic benefits to cultured meat that are appealing to many consumers and may be included as positive information. They include problems with conventional meat, animal welfare (though, as mentioned previously, does not affect vegetarians), environmental-friendliness, healthiness, food safety (which ties in government's regulation) and world hunger. The researchers examined that including societal and personal benefits significantly increased acceptance.

Going forward, Tomiyama et al. (2020) suggested that the development of positive information and public perception on cultured meat will be greatly supported by food science, especially on improving flavor, texture and nutrition; behavioral science by identifying modifiable perceptions; and, academics who communicate science transparently to the public.

CONCLUSION

The acceptance of lab-cultured meat consumption is significantly related to the previous knowledge of lab-cultured meat and not correlated to the study majors (biology-related or not), year of study, and lifestyle (vegetarian or non-vegetarian). Hence, it can be concluded that age and educational level plays a more prominent role in the acceptance of cultured meat. Over two-third (69%) of the participants in this study had the willingness to try cultured meat before the provision of educational video. Interestingly, this study also found that a simple and short educational video on lab-cultured meat was able to increase by 79% the participants' willingness to consume the innovative food.

This study implies the public awareness of food and beverage scientific innovation, utilization of advertisement, and open-mindedness of young university students to innovation can be utilized as a strategy to market cultured meat products in Indonesia. Hopefully, this study provides more insight and contributes to the future marketization of cultured meat in Indonesia, especially in Jakarta. Further study can be done in non-urban rural areas, as this study was concentrated on Undergraduate students in Jakarta. Not only that, examples of other aspects can be explored in further studies including other age ranges (such as in adolescence and middle-aged to older adults), and other factors such as economics and policy sides. Besides, comprehensive studies to identify the research gap in laboratory infrastructure and business sides in Indonesia are not less important to add more insights of the production viability of this relatively new food

product. Moreover, further evaluation regarding the technicality of production and the most suitable branding strategies of cultured meat in Indonesia particularly are highly advised before being distributed to the local markets as meat substitutes.

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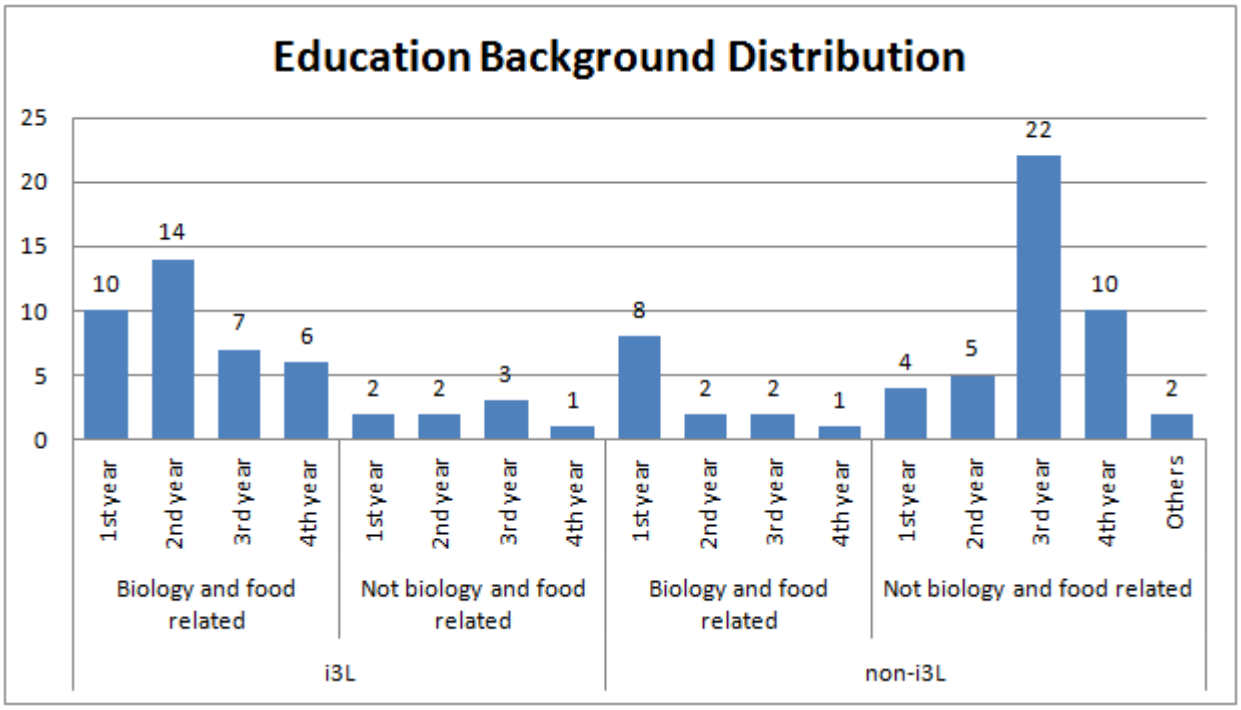
APPENDIX

Appendix 1. The demographic of respondents. Respondents were made sure to be an Undergraduate student from Jakarta. Total samples were 101 (n = 101).

Demographic categories	Frequency	Percentage (%)
Gender		
Male	57	56.4
Female	44	43.6
Origin of school		
i3L	45	44.6
Not i3L	56	55.4
Major of study		
Food and biology-related	51	50.5
Not food and biology-related	50	49.5
Year of study		
1st year	24	23.8
2nd year	23	22.8
3rd year	18	33.7
4th year	34	17.8
Others	2	2.0
Vegetarian status		
Vegetarian or vegan	25	24.8
Not vegetarian or vegan	76	75.2
Frequency of red meat consumption each week (for non-vegetarian or vegan)		
1-3 times a week	42	55.3
4-6 times a week	23	30.3
More than 6 times a week	11	14.5

Awareness of cultured meat existence and the source of information, if applicable		
Aware, mass media	11	10.9
Aware, social media	14	13.9
Aware, friends and relatives	6	5.9
Aware, lecture material	22	21.8
Aware, self-interest	4	4.0
Aware, others	1	1.0
Not aware	43	42.6
Level of understanding of cultured meat (For those aware of it)		
Know about how it is made	40	69.0
Not know about how it is made	18	31.0



Appendix 2. Education background distribution of the respondents.

Appendix 3. The list of questions asked to respondents on their perception towards cultured meat consumption.

No.	Sections	Questions	Options	Notes
1.	Demographic	Gender	Male or female	

		University	i3L and other	
		Major	Biology and food-related or not biology and food-related	Examples of majors are given to ease the decision process.
		Year of study	1, 2, 3, 4, or other	To see the distribution of the respondents level of knowledge
2.	Self-assessment	Value on the naturalness of food	1 to 5 scale with 1=very disagree, 2=disagree, 3=neutral, 4=agree, 5=very agree.	To cluster the responses into 4 separate clusters: natural food consumer, open-minded food consumer, environmentalist, and life qualities advocate.
		Open-mindedness and eagerness to accept new things		
		Concern to environmental issues		
		Value on life qualities (health, content, etc)		
3.	Vegetarian status		Either vegetarian or vegan	Go to section 4.
			Neither vegetarian nor vegan	Go to section 5.
4.	Vegetarian section	Motivation to become a vegetarian or vegan	Influence of religions of beliefs	Respondents are allowed to choose more than one answer.
			Health benefits	
			Maintain ideal body weight	
			For animal welfare	
			Save environment	
5.	Non-vegetarian section	Frequency of eating red meats and products derived per week	1-3, 3-6, or more than 6	
6.	Previous knowledge on cultured meat	If the respondent ever heard about the term before	Yes or no	If yes, go to section 7.

7.	Ever heard about the term	Source of information	Mass media, social media, friends and relatives, college lecture, or self-interest	Only 1 answer per question; To trace where the respondent knew about it.
		If the respondent knows how it is made.	Yes or no	To make sure he/she has a considerable amount of knowledge regarding cultured meat.
8.	Data validation	Consists of a simple question that should be answered correctly if the respondent is paying full attention. Any wrong answer will lead to form submission and will be discarded.		
9.	Willingness to consume cultured meat	If the respondent willing to eat it if served	Yes or no	As a pre-test. If yes, go to section 10; If no, go to section 11.
10.	Willing to consume cultured meat section	The reason behind it.	Interested to try	Respondents are allowed to choose more than one answer.
			Reduces animal slaughtering	
			Slows the rate of global warming	
			The ability to solve the problem of the growing world population	
			Reduces the use of water, land, and energy in farming	
11.	Not willing to consume cultured meat section	The reason behind it.	Uncomfortable because the 'unnaturalness'	Respondents are allowed to choose more than one answer.
			Skeptical about the taste (i.e. Not tasty)	
			Skeptical about the presence of any harmful substances	
			Not sure if his/her religion or belief support it	
12.	Post-test	As a post-test, an educational video about cultured	The same with post-test or there is a change in decision	If there is a change in decision, the motivation will be asked (the options

		meat is presented and the respondents' willingness is re-asked.		are similar to Section 10 and 11 according to the choice, respectively).

Appendix 4. The 2 × 2 contingency table, which shows the outcomes of two tests on a sample of *n* subjects.

	Test 2 positive	Test 2 negative	Row total
Test 1 positive	*a*	*b*	*a* + *b*
Test 1 negative	*c*	*d*	*c* + *d*
Column total	*a* + *c*	*b* + *d*	*n*