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Analyzing Consumer Perceptions of Alternative Proteins Cultured Meat and Edible Insects

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Abstract

The issue of protein alternatives to traditional livestock proteins has been highlighted in view of food security and carbon neutrality policies. The purpose of this study was to assess consumer awareness regarding alternative proteins through a consumer perception survey. The aim was to contribute to the advancement of scientific understanding in the field of alternative proteins and to provide recommendations for appropriate policies and technical orientations. The survey was conducted on 500 adults over the age of 18 nationwide, centering on an online panel survey using a structured questionnaire. In this study, cultured meat and edible insect proteins were investigated among alternative proteins (cultured meat, edible insects, and plant-based proteins). Cultured meat was recognized by 64.6% and edible insects by 90.2%. Respondents were more inclined towards cultured meat over edible insects, with a preference for cultured meat due to resource conservation and environmental protection. Edible insects were favored for their economic value in ensuring food security. The sentiment that prioritizing the development of cultured meat over edible insect protein is essential found strong support in South Korea. The study's findings confirmed a substantial awareness of alternative protein sources, with a notable emphasis on the significant demand for cultured meat technology.

Keywords

Cultured meat
Edible insect
Alternative protein
Consumer awareness
Survey analysis

1. Introduction

The issue of securing alternative proteins is gaining attention as part of food security and carbon neutrality policies [1]. In particular, according to the World Population Prospects for 2050, the world population will exceed 9.7 billion in 2050, and the future demand

for meat will reach 4.5 tons [2,3], resulting in a food security crisis [4,5].

Meanwhile, the food industry has been increasingly emphasizing the necessity of reducing greenhouse gas emissions within the livestock sector as part of the efforts to attain carbon neutrality in response to the climate crisis [6].

Carbon neutrality involves minimizing greenhouse gas emissions resulting from human activities while also offsetting and removing any remaining greenhouse gases. This approach aims to achieve a net emissions level of zero (or "zero emissions"), where the total carbon emitted and the carbon absorbed are in balance. This equilibrium results in a net carbon emission of zero, commonly referred to as "net zero" [7]. As carbon neutrality emerges as a global topic in response to the climate crisis, the need to reduce greenhouse gas emissions, especially in the livestock industry, has also been increasingly highlighted [8]. In addition, the livestock industry is facing increasing concerns about safety and sustainability due to livestock diseases such as foot-and-mouth disease, avian influenza, and African swine fever, and many problems have been pointed out in terms of animal welfare [9].

Due to limitations such as population growth, climate change, and resource depletion, it is predicted that the traditional livestock industry, which relies on raising livestock, will not be able to meet the increasing demand for meat protein production [10]. Therefore, difficulties in securing protein production may occur and food security issues may arise [11]. Therefore, various studies have been conducted on alternative protein production using food technology [5,12,13]. However, most of these studies focus on innovative science and technology without considering consumer acceptance [14,15]. Scientific advances have led to the emergence of technologies that can produce various alternative proteins, but most of these technological developments are still far from consumer awareness [10,16]. Hence, this study was carried out to gauge consumer awareness about alternative proteins via a survey. It aimed to contribute to the scientific advancement of alternative proteins, guide policy decisions, and drive technological innovations. Additionally, the consumer awareness survey on alternative proteins laid the groundwork for the development of diverse alternative protein production methods.

Therefore, in this study, we analyzed consumer perceptions of cultured meat and edible insects.

2. Research methods

This study examined how consumers perceive cultured meat and edible insects as alternative protein sources. Its objective was to gauge consumer awareness of alternative proteins through a survey focused on consumer perceptions and to use the findings to inform policy and technology directions. The study was conducted between August 17, 2022, and August 22, 2022. The survey was conducted through an online panel survey using a structured questionnaire. The survey was conducted on adults aged 18 and over nationwide through an online survey platform. Data collection and analysis methods were performed using SPSS. The collected data underwent coding and editing. After thorough verification and validation, the data underwent frequency analysis, crosstabs analysis, and mean statistical analysis using the SPSS statistical software. A 5-point scale was employed to calculate satisfaction scores in the evaluation. Data validation included a comprehensive review of each question, and logically inconsistent data were removed following scrutiny of the questionnaire. Moreover, over 30% of the survey data was randomly cross-verified. In order to improve the accuracy of the survey results, the proportion of both genders of the respondents in the survey was equal. 17.8% of the respondents were in their 20s, 18.0% in their 30s, 21.6% in their 40s, 23.2% in their 50s, and 19.4% in their 60s. The places of residence of the respondents included Seoul 18.8%, Incheon and Gyeonggi 32.0%, Daejeon and

Chungcheong 10.4%, Gwangju and Jeolla 9.6%, Daegu and Gyeongbuk 9.8%, BuUlGyeong 15.0%, and Gangwon and Jeju 4.4%.

3. Analyzing consumer perceptions of cultured meat

The results of consumer awareness and interest in cultured meat are shown in **Table 1**. The percentage of consumers who knew or had heard of cultured meat was 15.6% and 49%, respectively, while the percentage of consumers who had no knowledge of it was 35.4%. Public awareness is the most important factor for consumer acceptance to promote cultured meat consumption [17]. Therefore, the awareness rate of cultured meat among domestic food meat consumers was 64.6%, indicating that more than half of the consumers were aware of the potential marketability of cultured meat. In addition, the proportion of consumers who are interested in cultured meat was quite large at 81%. The results of the interest analysis are shown in **Table 2**. Among consumers who are interested in cultured meat, 42.2% of respondents were interested in cultured meat due to environmental concerns. In addition, consumers are interested in cultured meat for animal welfare or ethical reasons (21.2%), hygiene of the slaughtering environment (20.7%), and health promotion (14.6%). When asked about the need for cultured meat business (**Figure 1A**), 68.2% of the respondents felt the need to develop cultured meat, and when asked about their willingness to purchase it (**Figure 1B**), 47% of the respondents said they were willing to purchase it. Therefore, environmental safety, animal welfare, and hygienic production will be important aspects in the development of the cultured meat industry. Various studies have also shown that consumers are willing to purchase cultured meat for environmental and ethical reasons [17], and the increasing experiential factor of consuming cultured meat has helped improve the perception towards cultured meat [18]. In the Chinese market, the willingness to pay for cultured meat was discovered to be approximately 70% higher. Male consumers and individuals with higher levels of education exhibited a stronger preference for cultured meat [19]. In Korea, it was also found that education level and gender had a significant effect on the preference for cultured meat [20]. Until now, the majority of research papers have indicated a rise in consumer preference for cultured meat following awareness surveys and information disclosure. Conversely, in the Netherlands, consumer preference for a product resembling conventional meat in taste and aroma was explored after disclosing solely that it was cultured meat. The findings demonstrated that the product labeled as cultured meat was perceived to be more appealing [18]. Hence, enhancing the availability of cultured meat by introducing prototypes, combined with the advantageous aspects associated with consuming cultured meat, could facilitate the future expansion of the market.

However, 17.8% of the respondents do not purchase cultured meat due to various factors such as preference for traditional meat (22.1%), repulsion against artificially made protein (21.1%), health hazards (15.8%), ethical issues (13.7%), concerns about mutation to a cancer cell (13.7%), non-environmentally friendly (10.5%), and vegetarianism (3.2%). Among them, only 6% of respondents said that cultured meat should not be developed, highlighting the need to develop cultured meat. The high cost of cultured meat development technologies and the price of prototypes are also factors that may affect consumer acceptance [18]. In a survey of the Dutch public, who are active in the development of alternative meats, price was the most important factor that could lead to a negative view of the consumption of cultured meats [18]. Escribano *et al.* categorized Spanish consumers of cultured meat into three distinct groups: the first group consisted of individuals under 30 years of age with lower financial capabilities and high price sensitivity; the second group expressed concerns regarding environmental or health aspects, and the third group displayed an indifference to meat consumption. However, up to now, taste ratings for cultured meat have

Table 1. Awareness and interest degree of cultured meat and edible insects

Subjects (*n* = 500)		**Option**	**Percentage (number)**
Cultured meat	Awareness of cultured meat	Fully aware	15.6 (78)
		Slightly aware	49.0 (245)
		Unaware	35.4 (177)
	Interest in cultured meat	Extremely interested	3.2 (16)
		Interested	32.8 (164)
		Slightly interested	45.0 (225)
		Uninterested	15.8 (79)
		Extremely uninterested	3.2 (16)
Edible insects	Awareness of edible insects	Fully aware	45.0 (225)
		Slightly aware	45.2 (226)
		Unaware	9.8 (49)
	Interest in edible insects	Extremely interested	3.2 (16)
		Interested	21.4 (107)
		Slightly interested	36.8 (184)
		Uninterested	27.8 (139)
		Extremely uninterested	10.8 (54)

Table 2. The reason for interested or uninterested in cultured meat

Subjects	**Option**	**Percentage (number)**
The reason for being interested in cultured meat (*n* = 405)	Resource-saving and animal protection	42.2 (171)
	Ethicality and animal welfare issues	21.2 (86)
	Sanitation problem of farms and slaughterhouses	20.7 (84)
	Health issues	14.6 (59)
	Others	1.2 (5)
The reason for being uninterested in cultured meat (*n* = 95)	Preference for conventional meat product	22.1 (21)
	Repulsion against artificially made protein	21.1 (20)
	Concerns about potential health problems	15.8 (15)
	Ethical problems of cell harvest and culture process	13.7 (13)
	Concerns about mutation to cancer cell	13.7 (13)
	Concerns about environmental friendliness	10.5 (10)
	Vegetarian	3.2 (3)

notably lagged behind those for traditional meat [21]. This discrepancy is believed to stem from a combination of factors, encompassing resistance to novel foods, stability concerns, unfavorable quality attributes, and the perception that cultured meat is less healthful than conventional meat [22].

To augment interest in cultured meat, it becomes imperative to accentuate its resemblance to traditional meat and to advance the creation of secure food products utilizing natural resources [17].

4. Analyzing consumer perceptions of edible insects

The results of consumer awareness and interest in edible

insects are shown in **Table 1**. 45.0% of the respondents were aware of edible insects, and 45.2% had heard of them, which makes up 90.2% of awareness. This could be attributed to the historical consumption of edible insects in Asian, African, and European cultures, as well as the contemporary recognition of edible insects as a potential food source for the future. Additionally, the ongoing research conducted both domestically and internationally has contributed to this heightened awareness [2]. On the other hand, 61.4% of consumers were interested in edible insects, with 3.2% being "very interested," 21.4% being "interested," and 36.8% being "slightly interested." On the other hand, 38.6% of consumers were not interested in edible insects, with 27.8% answering "uninterested' and 10.8% answering "extremely uninterested," showing a higher rate than cultured meat (19.0%).

The reasons for consumers' interest or lack of interest in edible insects are shown in **Table 3**. Among the consumers who are interested in edible insects, 36.5%, are interested in their economic value in ensuring food security, followed by 28.0% who are interested in their high protein content compared to meat. Edible insects offer several economic benefits, including greater feed efficiency for animal protein production compared to traditional livestock. They can also be raised in a relatively short timeframe and within limited space [9,22]. Currently, there are a total of nine types of edible insects allowed as food ingredients in South Korea, and among them, the crude protein content of brown leech larvae is about 50%, and 55%–78% for silkworms and grasshoppers. Considering that the protein content of traditional meat is 15.2%–34.7%, edible insects have a much higher protein content [23]. The next reason for consumer interest was the low greenhouse gas emissions compared to livestock (25.4%). From these results, it can be concluded that current consumers are highly interested in building a foundation for food security and solving environmental problems, and edible insects are being considered as a countermeasure. On the other hand, among the consumers who were less interested in edible insects, 61.7% were disgusted and rejected by the appearance of insects, and 24.8% did not feel the need to eat them. To address consumers' reluctance towards edible insects, recent research has incorporated edible insects into various food products like bread, cereals, sausages, and more. This has been achieved through processes such as powdering, extraction, and decomposition technologies, with a focus on assessing the quality attributes and functional properties of these products [9].

Edible insects have been developed into processed

Table 3. The reason for being interested or uninterested in edible insects

Subjects	Option	Percentage (number)
The reason for being interested in edible insects (n = 307)	Economic value for ensuring food security	36.5 (112)
	Higher protein content than meat	28.0 (86)
	Lower emission of green-house gases than traditional livestock	25.4 (78)
	Suitability for weight-control	8.1 (25)
	Others	2.0 (6)
The reason for being uninterested in edible insects (n = 193)	Unappetizing	61.7 (119)
	Unnecessary food source	24.9 (48)
	Not appropriate for domestic culture	4.7 (9)
	Speculation about unpleasant taste	3.6 (7)
	Concerns about allergy	2.1 (4)
	Possibility of heavy metal pollution	1.6 (3)
	No nutritional value	1.0 (2)
	Expensive	0.5 (1)

foods such as cookies, cereals, and bars at home and abroad so that they appeal to the public, and their application has expanded, such as adding them to sauces [10]. There are commercialized edible insect products in the market, and 11.0% of our respondents have purchased these kinds of products (**Table 4**). When we investigated the purpose of purchase among these buyers, 34.5% of them purchased them out of curiosity, and 25.5% of them purchased them as a meal or snack. This suggests that edible insect products are not yet popular. The preferred form of edible insects include energy bars and snacks at 16.8%, a blend of edible insects with other ingredients at 15.1%, and powdered insects processed in a blender at 15.0%. On the other hand, the percentage of those who did not eat any form of edible insects and the percentage of those who did not respond were 16.4% each, which also shows the rejection of edible insects by consumers. However, previous studies have shown that 70.1% of Korean consumers were willing to consume edible insects again, with positive evaluations of taste and nutrition [24]. Hence, it is hypothesized that the substantial rejection could be attributed to limited consumption experience. An upsurge in consumption exposure might potentially lead to a shift in the proportion of preferred product forms.

When examining the need to develop the domestic edible insect business, 48.2% of respondents answered positively, with 7.6% strongly agreeing and 40.6% agreeing, while 16.0% answered negatively, with 5.2% disagreeing and 10.8% strongly disagreeing (**Figure 1A**). However, when inquired about their future purchasing intent for edible insects if the industry experiences revitalization, the responses were as follows: 23.8% of respondents answered "extremely interested," 3.4% answered "interested," 20.4% answered "neutral," and 18.4% answered "extremely uninterested." Additionally, 25.6% responded "uninterested," leading to an overall negative response rate of 44.0% (see **Figure 1B**). These results suggest that consumers are currently positive about the need to develop the edible insect industry, but are reluctant to purchase and consume them directly. Given the low consumption experience of edible insect foods, a shift in perception through positive exposure is needed to alleviate this reluctance [25]. A key strategy for eliciting positive evaluations of insect-enhanced

Table 4. Experiences of purchase and intake of edible insects, and the preferred food type made with edible insects

Subjects	Option	Percentage (number)
Experience in purchasing and consuming edible insects	Experienced	89.0 (445)
	Unexperienced	11.0 (55)
Purpose of purchasing edible insects (n = 55)	For the sake of curiosity	34.5 (19)
	As a meal/snack	25.5 (14)
	High nutritional value	12.7 (7)
	For the prevention/cure of diseases	12.7 (7)
	Participation in the consumption of substitute food	9.1 (5)
	Environmental friendliness	5.5 (3)
The preferred food type made with edible insects (n = 500)	Energy bar/snack	16.8 (84)
	Mixed with other ingredients	15.1 (76)
	Powdered type	15.0 (75)
	Energy drink/protein shake	9.1 (45)
	Decomposed form of edible insects	8.0 (40)
	Original form of edible insects	2.8 (14)
	Others	0.4 (2)
	None	16.4 (82)
	No response	16.4 (82)

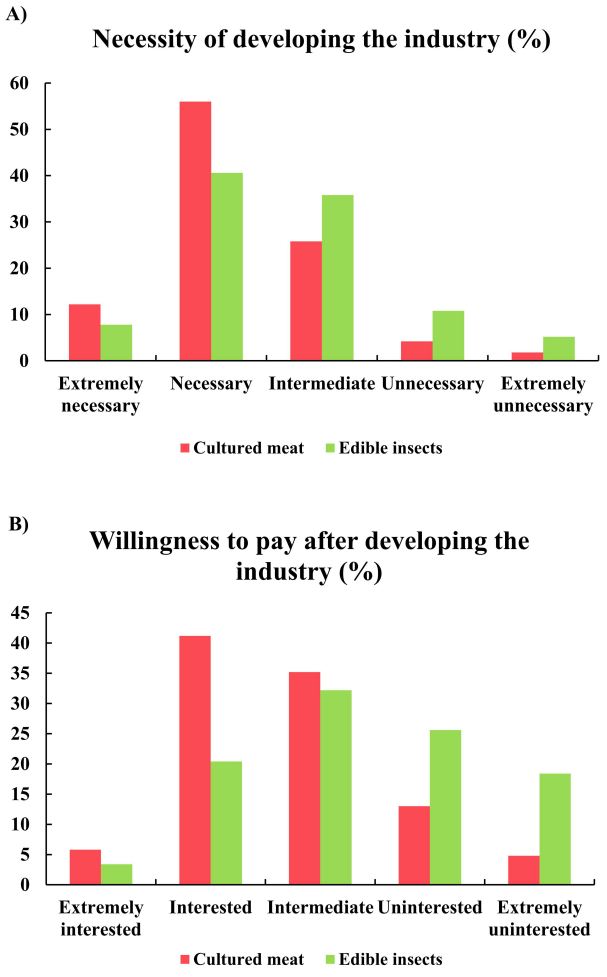

Figure 1. Necessity of developing the cultured meat and edible insect industry and willingness to purchase related products

foods is to make the archetype invisible and therefore unrecognizable [26]. Furthermore, rejection of edible insects may not only be due to their appearance but also to concerns about the safety of an ingredient that has never been consumed as food [22]. Previous studies have shown that edible insects may pose potential risks for microorganisms, parasites, chemicals, and allergies [27]. Therefore, there is a need for active research and promotion of positive exposure to edible insects, their safety, and nutritional and environmental value, as well as the development of various forms of products to reduce rejection.

5. Conclusion.

This study was conducted to investigate consumer perceptions of cultured meat and edible insect protein, two alternative proteins that are gaining prominence for food security and carbon neutrality, with the aim of providing policy and technical direction for alternative proteins. The study found that 64.6% of consumers were aware of cultured meat and 90.2% were aware of edible insects. The respondents were generally more interested in cultured meat than edible insects. The reason for choosing cultured meat was mainly for resource conservation and environmental protection. Edible insects were chosen for their economic value for food security. In Korea, there is a strong consensus that the development of cultured meat is more imperative than that of edible insect protein. Specifically, the demand for cultured meat technology is notably greater than that for edible insect protein. Therefore, there is a considerable need to develop cultured meat and edible insect protein technology, and various food technology development based on consumer perception is necessary. Furthermore, it is essential for government authorities to provide policy backing for the advancement of such technologies and to actively promote the safety and necessity of alternative proteins.

Disclosure statement

The authors declare no conflict of interest.

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