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Determinants and Consequences of Using Lab-Grown Meat in Egyptian Tourist Food Establishments: Evidence from Customers' Perspectives

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Abstract

As innovation foods, once tourist food establishments use new food products, they will face different reaction concerns and questions from customers about this new technology. This research aims to identify the extent of the Egyptian consumer's acceptance and willingness to eat lab-grown meat. For achieving research aim, a questionnaire was designed and distributed to a random sample of customers in Egyptian tourist food establishments, 523 valid responses were received and analyzed by SPSS V.28. The results indicated that customers do not have enough information about lab-grown meat to accept the experience of eating it in the future. This information includes sensory characteristics, nutritional value, and environmental characteristics, the religious and moral aspects compared to natural meat, in addition to the cost factor of lab-grown meat. Therefore, maybe customers' acceptance and confidence in lab-grown meat is the major obstacle to the marketing process of this new product in Egyptian food establishments. Based on the results, some recommendations were suggested and directed to food science professionals, factory owners, restaurant owners, chefs, and food establishments. One of the main recommendations was that Egyptian customers should be made aware of lab-grown meat through corporate media and publicity for the sustainability and safety of food and nutrition and the health of lab-grown meat through the dissemination of adequate information about lab-grown meat by food science professionals.

Introduction

According to **Hong *et al.* (2021)**, the technology of Lab-grown meat from animal cells is itself an innovative method of producing meat for human consumption. Cultured meat or lab-grown meat has emerged as an innovative trend in the field of food science and technology, which requires modern biotechnological methods for its production and development. Lab meat is real meat that is produced by culturing cells in a laboratory through modern technological techniques, not slaughtering animals. While it is likely that customers will not be interested in cultured meat technology as long as the product is not available and the time to save is uncertain, customer insight is essential for the acceptance of the product in the market in the future **(Padilha *et al.*, 2022).** The first burger meat appeared in the laboratory on August 5, 2013, and since then the scientific view of cultured meat has spread and developed. Accordingly, believes that the acceptance of lab-grown meat may depend more on

the concrete implementation of food production technology and process size in the future, he also added that he considers meat Individually produced lab-grown meat is especially unnatural, while if produced on a large industrial scale by multinational food companies, it makes lab-grown meat more palatable to customers **(Post, 2014; Sato, 2020).**

According to **Bennett (2021),** Singapore is the first country to adopt lab-grown meat, through a food technology company called *"Eat just*" that specializes in the production of meat and egg substitutes. The world's first commercially branded farmed meat product called *"Cultured chicken"* was grown by the Singapore Food Standards Agency in December 2020, and the product is served by a restaurant called *"1880"* at an estimated price of around $23 a meal **(Rahman, 2022).**

Research Problem

There are many studies published so far in the field of natural sciences that have focused on the technological aspects, productivity, progress, and challenges of meat farming, these concerns are resolvable in the future **(Post, 2014; Treich, 2021)**, so a large number of social science studies have focused on the social, philosophical, economic, and ethical arguments for that innovative technology **(Letti *et al., 2021;* Mancini and Antonioli, 2022).** The research problem lies in the fact that, although lab-grown meat is already quite a recent development, customers in food establishments may not be interested in the technology of lab-grown meat and have doubts and fears about this new product.

Research Aim

The research aims to identify the doubts, questions, and problems that the customer needs to know about this new technology, and the acceptance of customers in food establishments, whether they are willing to accept this new food under any circumstances or not. This study focuses on increasing customers' awareness of laboratory meat and their acceptance and conviction of the product and their desire to eat it after adding new information about this technology.

Research Hypotheses

Based on the researcher's reading on the issue of lab-grown meat and the informational effects and the extent of its contribution to the acceptance of lab-grown meat by customers, the research hypotheses could be suggested as follows:

Hypothesis1: The determinants of using lab-grown meat are significantly impact on customers' acceptance at Egyptian food establishments.

H1.1 CA is significantly affected by Sensory properties of LGM.

H1.2 CA is significantly affected by Nutritional value of LGM.

H1.3 CA is significantly affected by environmentally impact of LGM.

H1.4 CA is significantly affected by Cost of LGM.

H1.5 CA is significantly affected by religious aspect of LGM.

Hypothesis 2: There are significant differences between the customers of acceptance lab-grown meat according to demographic.

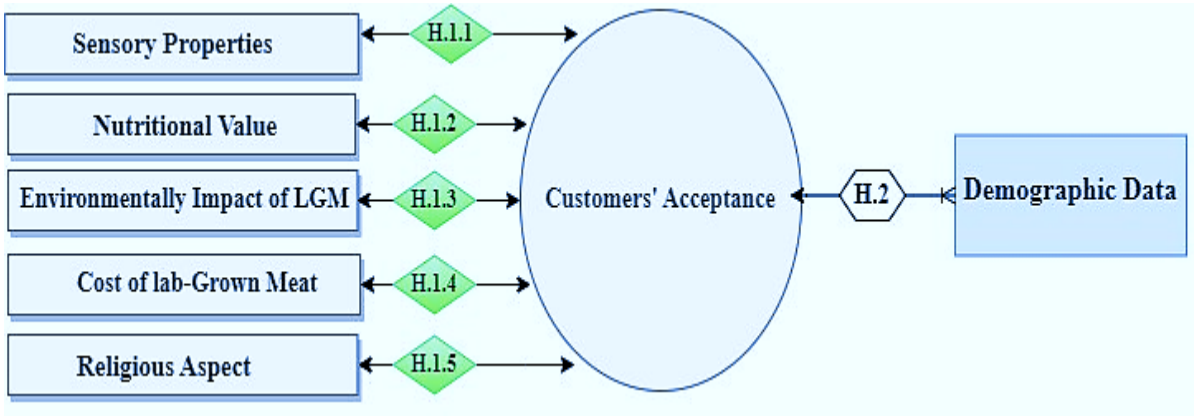

Figure1.: The proposed Research Framework and Hypotheses

Literature Review

A Brief History of Lab-Grown Meat

The idea of lab-grown meat has been around for a long time, with no technology to apply it. Lab-grown meat was first mentioned in 1897 in the science novel "*Auf Zwei*" Planeten **(Treich, 2021)**, and it appeared in a number of other novels in the 19th century. The past is like Ashes, Ashes, and in 1931, Winston Churchill famously predicted: "We shall abandon the traditional method of raising a whole chicken to eat its breast or its wing, by growing these cuttings separately under a medium suitable for growth", naturally, they will be used Synthetic foods are also in the future **(Safdar *et al.*, 2022)**. The National Aeronautics and Space Administration (*NASA*) has grown lab-grown meat in the lab as part of research to produce food for long journeys through outer space, and lab-grown meat eaten by humans was the work of a biologist, Oron Catts in a 2003 project called "Disembodied Cuisine" in which he was able to grow cells from a frog and present them as steaks of a young frog during a dinner at the Museum in Nantes, France **(George, 2020).** The greater the customers' desire, attitudes, and intentions towards the experience and eating of lab-grown meat, the more there is an initiative from all production agencies to adopt the manufacture of lab-grown meat and all its alternatives **(Wilks and Phillips, 2017; Van Loo *et al.*, 2020).**

The in vitro muscle tissue growth technique has been available for more than 100 years **(Woll and Bohm, 2018)**. According to **Post (2014)**, in 2013 scientist Mark Post grew meat in his laboratory at Maastricht University in the Netherlands, and the first lab-grown burger was recorded in 2013 at a cost of $ 330,000, but the production of the same burger two years later was actually able to bring the cost down to $11.36. where was launched by Riverside Studios in London on a team Specialist, New Harvest also called for start-up plans to promote cell farming for in vitro meat production, and accordingly many cultured meat projects such as Shojin Meat Project, Memphis Meat, Super Meat and Finless Foods were implemented in 2018, 2019 and 2020, respectively. Finally, a US-based start-up implemented a lab-grown chicken meat project in food establishments in Singapore in December 2020 and was the first country to officially adopt the sale of lab-grown meat to its customers **(Bryant, 2020; Bryant and Barnett, 2020; Weinrich and Gassler, 2021)**.

There are two major organizations that have embraced the scientific research and development of lab-grown meat to date are New Harvest and the Good Food Institute, and there are about 50 start-ups around lab-grown meat and poultry as well as the farming of seafood and crustaceans **(Cameron and O'Neill 2019; Rubio *et al.*, 2020; Singh *et al.*,**

2023). Firms in the USA and the EU with a few firms in the Middle East and East Asian countries **(Rubio *et al,* 2020),** moreover, important technological improvements are still needed in the cultured meat production process. Efficient and mass-produced for the expected operating scale, from cell selection, through growth medium optimization, to cell biomaterials, and animal tissue engineering **(Post *et al.,* 2020; Kang *et al.,* 2021; Chodkowska *et al.,* 2022).**

Lab-grown Meat Production

According to **Chriki *et al.* (2022),** most animal welfare organizations encourage the production of lab-grown meat as a viable alternative to the slaughter of domestic animals. Meanwhile, the demand for food, especially meat, increases, the future of food security is certainly in danger**.** Also, natural meat production involves huge uses of land, energy, water, and time **(Krol and Tawil, 2023)**. According to the Food and Agriculture Organization **(FAO, 2022)**, it indicated in its report that in 2006, the land used for meat production was about 30%, along with 8% of the consumption of clean water **(Ward, 2022)**. Thus, the production of lab-grown meat greatly enhances the preservation Sustainability of environmental resources and animal welfare **(Escobar *et al.,* 2021; Lettia *et al.,* 2021; Yasuyuki, 2021; Septianto *et al.,* 2023).**

According to **Xin, *et al.* (2021)**, the process of producing Lab-grown meat is a set of animal tissue engineering processes and the use of biomaterials needed to manufacture a food product suitable for human consumption, so it is divided into four basic stages: (1) sampling from cells Muscles from the animal's body, (2) placing muscle cells in the appropriate medium for growth, (3) proliferation of muscle tissue, connective tissue, and fat, (4) collecting, processing, and converting all cultured cells into edible cuts of meat such as steaks and burgers (Fig.2).

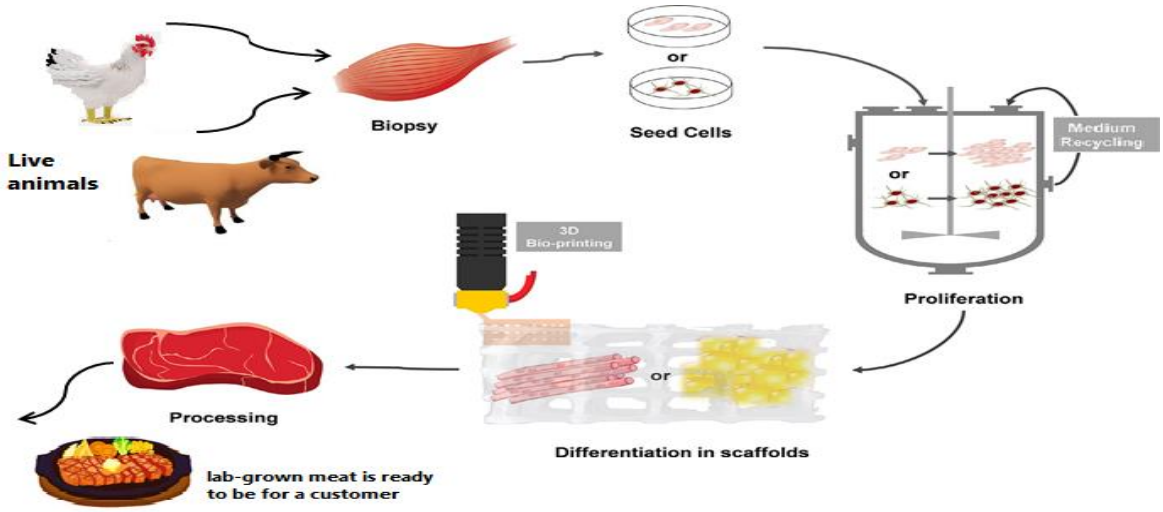

Figure 2: Main production process of lab-grown meat

Source: Developed by the Researchers based on **(Xin, *et al.,* 2021)**

Stage 1: Stem cells are living animal cells that can reproduce rapidly and in superior quality to produce muscle fibers, fat tissue and other types of tissue that make up muscle tissue **(Genovese *et al.,* 2017; Kadim *et al.,* 2015; Ramani *et al.,* 2022; Edison, 2022; Ramesh and Mahajan, 2022)**. Accordingly, these cells can be obtained in high quality by taking live animal tissue after isolation by digestive enzymes, mechanical perturbation, and purification by flow sorting using very fine surface criteria **(Ding *et al.,* 2017; Sergelidis, 2019)**. Various

tissue sources can also be used to produce lab-grown meat; Each cell type requires an ex vivo growth strategy according to its own tissue structure characteristics **(Stephens *et al.*, 2018; Fish *et al.*, 2020; Zhang *et al.*, 2020)**.

Stage 2: After collecting live stem tissue from animals, they require to multiply to produce huge amounts of muscle fibers and adipose tissue. As the volume of laboratory culture of vials or plates is far from meeting market demand. Accordingly, a large-scale bioreactor system for the production of lab-grown meat must be established and operationalized to meet market demand **(Post *et al.*, 2020)**. In addition, an economical, serum-free medium must be used and various factors such as pH, dissolved oxygen, carbon dioxide, concentration of important nutrients and metabolic waste must be monitored online in order to exploit resources efficiently and reduce production costs. It is also important to automatically recycle and remove toxic waste and replenish nutrients based on production control observations **(Allan *et al.*, 2019; Behera and Adhikary, 2023)**.

Stage 3: If the required amount of tissue transplant is achieved, the tissue is required to separate into muscle tubes, fat cells, connective tissues, or other forms of developing fibers. The cellular maturity scale is an important indicator for assessing this stage because muscle composition profiles and nutritional content including amino acids, lipids, vitamins, and minerals are clearly influenced by the maturation of animal tissue **(Liu, 2019; Balasubramanian *et al.*, 2021)**. Stem tissues have the advantages of robust muscle detachment, as the diameter and length of myofibers of proteins and their ex vivo amino acid content vary widely according to in vitro condition and are rarer than true muscle fibers. Accordingly, the dissociative state and increased tissue growth should be permanently improved in line with the criteria and mechanism of muscle tissue development in vivo animal **(Braga *et al.*, 2017; Sergelidis, 2019; Lamarche *et al.*, 2021)**.

Stage 4: As a final step in the production of lab-grown meat, the growing tissue is harvested and processed, including the addition of flavoring, coloring, and shaping, to give the final shape to lab-grown meat **(Zhao *et al.*, 2019)**. Since a conventional tissue culture approach can only form a thin two-dimensional (2d) cell layer, capture of muscle fibers, adipose tissue, and connective tissue is necessary to mount a piece of meat into a structure similar to conventional meat **(Stevens *et al.*, 2018)**. The implementation of an initial shape can be incorporated into step 3 where different types of cells are grown in a three-dimensional (3D) growth environment for technological biomimetics provided by serum-first "aqueous mixture" hydrogel **(Tuomisto, 2019; Balasubramanian *et al.*, 2021)**. In addition, advances in 3D bioprinting technology make it promising to create muscle tissues of relatively large size and complex structures through detailed arrangement of tissue-loaded hydrogels, and finally, the latter product can be reached after adding nutrients to cuts of meat such as proteins, vitamins, flavors, and colorants **(Kang *et al.*, 2016; Siddiqui *et al.*, 2022).**

Benefits of Using Lab-Grown Meat in Food establishments

According to **Li *et al.* (2023)**, there are several advantages that influence customers' acceptance and intentions to perceive lab-grown meat and eat it in food establishments**.** Meanwhile, there are many motives that require nutrition scientists to produce laboratory-grown meat, including the large increase in the world's population, and the increase in demand for meat resulting from the high standard of living of individuals, environmental pollutants, animal welfare, and reducing costs especially in silly breeding, processing, and transportation **(Kubacak *et al.*, 2022; Hocquette, 2023)**. And finally, health concerns and doubts, according to statistics conducted by the World Health Organization and many specialized scientists, the world population in 2014 reached 7 billion **(Ahmad *et al.*, 2023)**. It

is subject to daily increase and is predicted to reach 97 billion in 2050 **(Kamalapuram *et al.*, 2021)**. It is estimated that the needs of individuals for meat will increase by approximately 37 percent from 1999 to 2050 **(Shan *et al.*, 2022).**

The use of lab-grown meat technology in a laboratory helps scientists specialized in animal tissue engineering in determining the nutritional value of it according to the needs of the human body **(Heidemann *et al.*, 2020; Levi *et al.*, 2022)**. This puts the cultured meat in the laboratory much better compared to the natural meat in terms of safety and health of the body, as there is an inferential relationship between eating meat and the increased risk of many diseases such as heart attacks, diabetes, gout, and cancer **(Gomez-Luciano *et al.*, 2019; Chriki and Hocquette, 2020; Fraeye *et al.*, 2020; Rao *et al.*, 2023**). The nutritional value of the cultured meat can be controlled in the laboratory through the addition of the fat components and components used in the production growth medium, also the ratio between saturated fatty acids and polyunsaturated fatty acids can be controlled **(Kong *et al.*, 2022 Zheng *et al.*, 2022)**. Saturated fats can be replaced with other types of healthy fats, such as omega-3 **(Martins *et al.*, 2019)**.

Customers' Perspective towards Lab-Grown Meat

According to **Ye *et al.* (2023),** customer acceptance of new products will determine the potential of the market and the food sector, because customers may be influenced by product information, since it has been shown that correct and adequate information influences customer acceptance and satisfaction with foods produced using innovative technologies **(McFadden and Huffman, 2017; Ching *et al.*, 2022; Chodkowska *et al.*, 2022; Kantono *et al.*, 2022; Padilha *et al.*, 2022)**. This also applies to customer acceptance of laboratory-grown meat **(Hocquette *et al.*, 2015; Siegrist *et al.*, 2018; Kumar *et al.*, 2021)**. According to **Weinrich *et al.* (2020)**, a study conducted in Germany on German customers showed that 57% of them intended to try it and the remaining half anticipate demand for regular lab-grown meat, based on the information being promoted for the product and here Germany shows that it is only moderately willing to accept laboratory-grown meat. There is also a study conducted in Belgium, where the study showed that 39.3% of Belgian customers said they would be willing to try to buy cultured meat, 11.2% refused to eat cultured meat, and 43.2% were neutral and said they would. I would love to try this. The study indicated that there are doubts about the customers' acceptance of cultured meat in terms of health, price, and sensory quality in terms of (taste - color - texture ... etc.) so that the lab-grown meat **(Dupont and Fiebelkorn, 2020)**. In the laboratory is acceptable to future customers, it is therefore necessary to provide sufficient information about laboratory-grown meat as it contributes to a large percentage of persuading customers to accept laboratory-grown meat **(Bryant and Sanctorum, 2021; Mateti *et al.*, 2022; Pakseresht *et al.*, 2022; Kumar *et al.*, 2023).**

Likewise, A study was conducted in China on three cities, namely Beijing, Qingdao, and Taiwan, where the results showed that the vast majority were not aware of lab-grown meat and showed that nearly 22% of customers are against lab-grown meat, and 50% neutral, and this percentage decreased after providing Information about lab-grown meat was attributed to 12% opponents and 40% neutral, and the study also showed that more than 70% of customers are willing to taste and buy lab-grown meat and their willingness to pay an additional amount estimated at 2.2 % compared to traditional meat, Accordingly the study states that providing sufficient information about this new food product is an effective way to encourage customers to be willing and accepting of lab-grown meat **(Zhang *et al.*, 2020; Fernandes *et al.*, 2022)**.

According to **Szejda *et al.* (2021),** a study conducted in the United States of America and the United Kingdom on the extent to which customers accept farmed meat, the study showed that a ratio of 54:59 % of customers are not knowledgeable about lab-grown meat, and more than one-third of customers are neutral and express their desire to try farmed meat with a percentage of 34: 41% and only 7% of customers in the United States and 5% in the United Kingdom were very familiar with this modern innovation in food, and the results show the openness reached by customers by 80% in both the United States and the United Kingdom. This shows how much customers want to experience sustainable artificial lab-grown meat and prefer non-GMO products with excellent nutritional value **(Liu *et al.*, 2022; Mateti *et al.*, 2022; Kouarfaté and Durif, 2023)**.

According to **Hamdan *et al.* (2018),** it was clarified that lab-grown meat from the perspective of Islamic law is halal if two main conditions are met: First, the stem cells must be derived from a slaughtered animal halal, and secondly, avoid using the blood or serum of fetal animals. This is what the religion of Islam has made clear in this innovative technology in food according to the rules laid down by God in the Qur'an and the holy books, Several alternatives to serum have been identified, such as mushroom and algae extract, in addition to taking stem cells from a slaughtered animal, so providing the two main criteria for the production of lab-grown meat can be applied in a way that suits Muslim customers, lab-grown meat has the potential to be a substitute for traditional meat for Muslim customers as long as it complies with halal standards **(Hamdan *et al.*, 2021).**

Research Methodology

To achieve the aim of the research, customers in food establishments were surveyed. The sample equation was applied to unlimited society **(Thompson, 2012)** as follows:

$$\boldsymbol{n} = \frac{N \times P(1-P)}{\{N-1 \times (d^2 \div Z^2)\} + P(1-P)\}}$$

N:Sample size, P: Percentage of the purpose of this study 0.50 , d: Percentage of the error limit allowed 0.05 , Z:The standard degree used for giving general results is 95%. Thus, the standard degree = 1.96

$$\mathbf{N} = \frac{\mathbf{500000 \times 0.50(1-0.50)}}{\{\mathbf{500000-1} \times (\mathbf{0.05^2 \div 1.96^2}) + \mathbf{0.05}\,(\mathbf{1-0.50})\}}$$
$$= \frac{\mathbf{125.500}}{\mathbf{325.63}} \times \mathbf{100} = \mathbf{385.40} \simeq \mathbf{385}$$

The population of the study is unlimited due to the difficulty of determining a specific number of customers in Egyptian food establishments, so the random sample size is an ideal method to apply in this study. According to **Thompson, (2012)** the lower limit of respondents that are suitable in this study is 385. A number of 523 electronic questionnaires were designed and distributed from 1 April 2023 to 1 September 2023. The questionnaire consisted of five sections. The first section is intended to reveal the customers' demographic data. The second section intended to include objective questions, including pictures of comparison between natural and cultured meat and the extent to which cultured meat is acceptable to customers in terms of eating quality, cost, and religious aspects. The third section explores the customer's acceptance of the composition and sensory properties of lab-grown meat in Egyptian food establishments (10 statements). The fourth section included the extent of customers' awareness of the nutritional value of lab-grown meat (5 statements). The fifth section included the extent of customers' awareness of the contribution of lab-grown

meat to preserving the environment (5 statements). The respondents were asked to answer these statements by using a five-point Likert-type scale (Strongly agree = 5, agree =4, don't know = 3, disagree = 2 and, strongly disagree = 1) to determine the levels of agreement with the statements investigated. The Statistical Package for the Social Sciences (SPSS) version 28.0 was used to analyze and compute the collected data. The range of each level of agreement was calculated as follow:

Table 1: Questions Answered Scale

Category	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Code	1	2	3	4	**5**
Range	1 – 1.80	1.81–2.60	2.61-3.40	3.41–4.20	**4.21 - 5**

Reliability Analysis

Table 2: Reliability Analysis

Number of Statements	Alpha
26	**0. 96**

Table 2 indicated that alpha coefficient of the questionnaires dimensions was **0.96** (higher than 0.70) **(Pallant, 2016).** This result indicated the reliability of the questionnaires for using in the study.

Results and Discussion

The results involved three main stages. Descriptive analysis was used to discover participants' responses, variance analysis for respondents' answers, correlation analysis, and regression were conducted to examine the relationship between independent variables and dependent variables. The results obtained were computed and analyzed in the following tables:

Table 3: Demographic Data of Customers.

Demographic Data	Attribute	Statistics		Rank
		Freq.	%	
Gender	Male	350	66.9	**1**
	Female	173	33.1	**2**
Total		523	**100%**	
Age	Less than 25 years	141	27.0	**2**
	From 25 – 40 years	181	34.6	**1**
	More than 40 years-Less than 60 years	138	26.4	**3**
	60 years and over	63	12.0	**4**
Total		523	**100%**	
Educational Level	educational degree	69	13.2	**3**
	university degree	258	49.3	**1**
	Postgraduate (Diploma- Master– PhD)	196	37.5	**2**
Total		523	**100%**	

As it can be observed from table 3 that, among the 523 respondents, a high proportion of the tested sample (66.9%) were male and (33.1%) of customers were female, a high proportion of the tested sample (49.3%) have a university educational degree and (37.5%) were have postgraduates' degree "Diploma-Master–Ph.D." and (13.2%) had average education "vocational/secondary school degree". As for the ages of the respondents, 34.6% of the respondents ranged in age from 25-40 years, followed by those less than 25 years old with 27.0%, then more than 40 years and less than 60 by 26.4%, and finally, those whose ages ranged from 60 years and above 12.0%**.**

Table 4: Customers' perceptions of lab-grown meat

Attributes	$\bar{x}$	SD	C.V	*Relative Weights*	*t*-test	*P*-Value	R
Sensory Properties							
The taste of lab-grown meat differs from that of natural meat.	3.21	.983	30.62	32.1 %	74.653	.000 *	**2**
Lab-grown meat tastes better than natural meat.	2.59	1.024	39.53	25.9 %	57.754	.000 *	**10**
The texture of lab-grown meat differs from that of natural meat.	3.25	.940	28.92	32.5 %	78.996	.000 *	**1**
The texture of lab-grown meat is better than that of natural meat.	2.75	1.026	37.30	27.5 %	61.389	.000 *	**8**
The color of lab-grown meat differs from that of natural meat.	3.17	.953	30.06	31.7 %	75.948	.000 *	**5**
The color of lab-grown meat is better than that of natural meat.	2.73	1.028	37.65	27.3%	60.803	.000 *	**9**
The aroma of lab-grown meat differs from that of natural meat.	3.20	.953	29.78	32 %	76.822	.000 *	**4**
Lab-grown meat aromas better than natural meat.	2.78	1.044	37.55	27.8 %	60.822	.000 *	**7**
The touch of lab-grown meat differs from that of natural meat.	3.21	.942	29.34	32.1 %	77.964	.000 *	**3**
The touch of Lab-grown meat is better than natural meat.	2.82	1.025	36.34	28.2 %	62.965	.000 *	**6**
Average of Responses	**2.97**	**0.991**	**33.70**	**29.7 %**	**----**	**----**	**----**
Nutritional value							
It is possible to control the percentage of fat in Lab-grown meat	3.49	.979	28.05	69.8 %	81.439	.000 *	**1**
Lab-grown meat contains cholesterol that is harmful to human health.	3.15	1.022	32.44	63 %	70.400	.000 *	**4**
Lab-grown meat benefits people in the work of a diet.	3.20	1.023	31.96	64 %	71.581	.000 *	**2**
Lab-grown meat contains the nutrients that the human body needs.	3.18	1.044	32.83	63.6 %	69.643	.000 *	**3**
Lab-grown meat is healthy from the point of view.	3.07	1.070	34.85	61.4 %	65.597	.000 *	**5**
Average of Responses	**3.21**	**1.027**	**32.02**	**64.2 %**	**----**	**----**	**----**
Environmentally Impact of LGM							
Lab-grown meat contributes to the preservation of the surrounding environment compared to natural meat.	3.32	1.078	32.46	66.4 %	70.511	.000 *	**5**
The use of lab-grown meat contributes to the prosperity of livestock.	3.40	1.080	31.76	68 %	71.894	.000 *	**1**
Lab-grown meat contributes significantly to reducing the environmental impact of livestock.	3.37	1.056	31.33	67.4 %	73.006	.000 *	**3**
Lab-grown meat contributes significantly to environmental sustainability and reduced energy use	3.34	1.069	32.005	66.8 %	71.363	.000 *	**4**
Animal welfare societies promote Lab-grown meat technology	3.40	1.026	30.17	68 %	75.720	.000 *	**2**
Average of Responses	**3.36**	**1.0618**	**31.54**	**67.2 %**	**----**	**----**	**----**

N= 523 $\bar{x}$**:** Mean **SD**: "Standard Deviation" **R**: Rank **CV**: Coefficient Variance (**SD** ÷$\bar{x}$ %) Relative Weights**:** Mean/scale × 100
*sig. ≤ (. 01)

The results in Table 4 show that the respondents do not have enough awareness about the sensory properties, nutritional value, environmental preservation, factors affecting use, and objective questions, with the average being between 2.15 and 3.36. Besides, the results show that there are significant differences among respondents towards the attributes of the table above which p-value ≤ (.05).

With regard to the dimensions of the sensory properties of the lab-grown meat in the laboratory, the respondents showed a neutral tendency towards most of the properties, and this means that they are not sufficiently familiar with the sensory properties of the cultured meat. Considering the responses of customers about their knowledge of the difference in the taste of lab-grown meat from natural meat (mean = 3.21, CV = 30.62), as well as the responses of customers about their preference for the texture of lab-grown meat over natural meat (mean = 2.75, CV=37.30). This result is consistent **with Bryant and Sanctorum (2021)**. While their responses were on the difference in the color of the lab-grown meat from the natural meat (mean = 3.17, CV = 30.06), As for their preference for the smell of lab-grown meat from the natural meat, their responses were the most neutral, and this indicates their inability to differentiate between them in smell (mean = 2.78, CV= 37.55).

According to the nutritional value dimension, the respondents showed neutral tendency towards most nutritional value properties, which means that they do not have sufficient information about the nutritional value of lab-grown meat. In detail, a large percentage of the sample agreed that it is possible to control the fat content in lab-grown meat (mean = 3.49, CV = 28.05), that result is consistent with **Li *et al.* (2023)**. While lab-grown meat contains a percentage of cholesterol harmful to human health (mean = 3.15, CV = 32.44) That result is consistent with **Rao *et al.* (2023)**. They also agreed that lab-grown meat is useful in making a diet (mean = 3.20, CV = 31.96), that result is consistent with **Zheng *et al.* (2022).** While dietary meat contains the nutrients needed by the human body (mean = 3.18, 32.83 CV), that result is consistent with **Ahmad *et al.* (2023).** They also agreed impartially that lab-grown meat is beneficial in terms of Healthy (mean = 3.07, CV = 34.85), that result is consistent with **Levi *et al.* (2022).**

With regard to the dimensions of Preserving the environment, the respondents showed neutral tendency towards most environmental practices, which means that they are not sufficiently aware of the extent to which lab-grown meat contributes to the preservation of the environment. In detail, farmed meat contributes to preserving the surrounding environment compared to natural meat (mean = 3.32, CV = 32.46). While the use of cultured meat contributes to the prosperity of livestock (mean = 3.40, CV = 31.76). While lab-grown meat contributes significantly to reducing the environmental impact of livestock (mean = 3.37, CV = 31.33). They also unbiasedly agreed that cultured meat contributes significantly to environmental sustainability and reducing energy use (mean = 3.34, CV = 32). 005), that result is consistent with **Kubacak *et al.* (2022) and Hocquette, (2023).** On the other hand, clients impartially agreed to encourage animal welfare associations to use lab-grown meat technology (mean = 40.3, CV = 17.30).

Table 5: The customers' visual perception of lab-grown meat

Factor	Variables	Frequency	Percentage (%)	Rank
Which of the following two pictures refers to lab-grown meat compared to natural meat?	Natural meat	238	45.5	2
	lab-grown meat	285	54.5	1
Total		523	**100%**	-

Note: Two different images of meat were shown to illustrate customers' visual perception of lab-grown meat

The results of Table 5 showed that the largest proportion of the respondents, 54.5%, chose the image of lab-grown meat in the laboratory, while 45.5% chose the image of natural meat, and this indicates the ability of the customer to distinguish between the sensory characteristics of the lab-grown meat and the natural meat in terms of appearance, smell and flavor, and texture, that result is consistent with **Post *et al.* (2020)**.

Table 6: The customers' perceptions about the cost of lab-grown meat

Factor	Variables	Frequency	Percentage (%)	Rank
What do you think about the cost of lab-grown meat?	less than natural	209	40.0	2
	Equal of natural	96	18.4	3
	More than natural	218	41.7	1
Total		**523**	**100%**	-

The results of Table 6 showed that the largest percentage of respondents 41.7% said that lab-grown meat in the laboratory is more expensive than natural meat, while 40.0% said that lab-grown meat is less expensive than natural meat, and finally 18.4% said that meat lab-grown meat is just as equal of natural meat in cost, that result is consistent with **Mancini and Antonioli (2022)**.

Table 7: The religious aspects of lab-grown meat

Factor	Variables	Frequency	Percentage (%)	Rank
To what extent do you consider the viability of laboratory-grown meat from a religious point of view?	Forbidden by law	69	13.2	2
	Halal with controls	418	79.9	1
	Halal	36	6.9	3
Total		**532**	**100%**	73.0

The results of Table 7 showed that the largest percentage of the respondents, 79.9%, considered the lab-grown meat as halal with controls, while 13.2% of the respondents considered the lab-grown meat as forbidden by Sharia, and finally, 6.9% of the respondents considered the lab-grown meat as halal according to Sharia. In this sense, **Hamdan *et al.* (2021)** claimed that lab-grown meat has the potential to be a substitute for traditional meat for Muslim customers as long as it complies with halal standards.

Table 8: Customers' acceptance of lab-grown meat in Egyptian food establishments

Factor	Variables	Frequency	Percentage (%)	Rank
Can you try eating lab-grown meat in Egyptian food establishments?	Strongly not accepted	52	9.9	5
	Not accepted	88	16.8	3
	Neutral	206	39.4	1
	Accepted	110	21.0	2
	Strongly accepted	67	12.8	4
Total		**523**	**100%**	-

The results of Table 8 showed that the largest percentage of respondents, 39.4%, expressed their acceptance of the lab-grown meat in the laboratory with neutrality, while 21.0% expressed their acceptance of the lab-grown meat in the laboratory with acceptance overeating it in Egyptian food establishments, that result is consistent with **Ye *et al.* (2023); Kumar *et al.* (2023) and Kouarfaté and Durif, (2023).** They also 16.8% expressed their acceptance of the lab-grown meat in the laboratory by not accepting and 12.8% expressed their acceptance of the lab-grown meat in the laboratory with strong acceptance of eating it in Egyptian food establishments, and finally, 9.9 % not strongly accepting its consumption in Egyptian food establishments.

Testing hypotheses

Table 9: Correlation coefficient between dependent and independent variables:

(Independent variables)		Dependent variable (acceptance)
Sensory Properties	Correlation	**.389****
	p-value	**0.00**
	N	**523**
Nutritional Value	Correlation	**.457****
	p-value	**.000**
	N	**523**
Environmentally Impact of LGM	Correlation	**.506****
	p-value	**0.00**
	N	**523**
Cost of Lab-Grown Meat	Correlation	**.120****
	p-value	**.006**
	N	**523**
Religious Aspect	Correlation	**.378****
	p-value	**.000**
	N	**523**

* = Highly significant at P≤ 0.05

With regard to Table 9, There are significant correlations between customers' acceptance of lab-grown meat and sensory properties (Corr = .389**), Nutritional value (Corr= .457**), Preserving the environment (Corr = .506**), Cost of lab-grown meat (Corr = .120**), Religious aspect (Corr = .378**). Based on this, it becomes clear that customer acceptance depends on the tissue properties of the cultured meat (such as (appearance, color, aroma, and texture), the nutritional value of the lab-grown meat in terms of fat and cholesterol, and the preservation of the environment such as (water and energy conservation and animal welfare) and this is consistent with **Rubio *et al.* (2020)**, and customers' acceptance of lab-grown meat also includes the cost factor, which significantly affects the customer to experience the lab-grown meat and this is consistent with **Woll and Bohm (2018)**, and from a religious point of view, for example (halal - forbidden - halal with controls) **as Hamdan explained *et al.*, (2021)**, accordingly it is necessary to provide adequate information about lab-grown meat as it contributes to a large percentage of clients' persuasiveness to accept lab-grown meat **Bryant and Sanctorum (2021)**.

Table 10: The Simple Regression

Factors Affecting on Customer's Acceptance	Parameters of Regression	T-test	p-value	Rank
(Constant)	-.561-	-2.292-	.022	-------
Cost of lab-grown meat	.082	1.827	.068	5
Religious aspect	.705	7.631	.000	1
Sensory Properties	.155	2.190	.029	3
Nutritional value	.127	1.571	.117	4
Environmentally Impact of LGM	.370	5.898	.000	2

* = Highly significant at P≤ 0.05

With regard to Table 10, it could be seen that; the values of the Parameters of Regression are less than 0.05. There is a significant effect at the 0.05 level of significance on the dependent variable. Religious aspect ranked as the first factor which affects customers' perceptions toward acceptance of lab-grown meat, and then preserving the environment was ranked as the second factor. Then the Sensory properties of lab-grown meat as a third factor, and nutritional value in the fourth degree, and finally, the cost of eating lab-grown meat was classified as the last factor that affects the perceptions of customers, transforming their acceptance to experience and eat lab-grown meat.

Table 11: T-Test & One-Way ANOVA Test

Demographic Data	DF	CI	T-Test	F	Sig.
Gender	521	0.95	1.084	-------	.293
Age	519	-------	-------	1.100	.348
Educational level	520	-------	-------	.549	.578

N= 523 $\bar{x}$: Mean Test value = (0.05) "DF: degrees of freedom CI: confidence interval **sig. ≤ (. 01)

With regard to Table 11, the results of the t-test for two independent samples showed that there are no statistically significant differences between customers in Egyptian food establishments in the extent of their willingness to go through the experience of eating lab-grown meat again for the gender where the test t = (1.084) and P-value (.293), (more than 0.5) This result shows the difference between respondents by gender Referring to The results of the one-way ANOVA test showed that there are no statistically significant differences between customers in Egyptian food establishments in the extent of their ability to experience the experience of eating lab-grown meat by age. F value = (1.100), P-value = .348 (more than 0.1), and at the same time, there are no statistically significant differences between customer's in Egyptian food establishments in the extent of their ability to experience eating lab-grown meat to the educational level where the F value = (.549), P-value = (.578), (more than 0.1).

Conclusion

This study presents an investigation into an innovative food production technique, namely, lab-grown meat. It has been found that customers in Egyptian food establishments do not have awareness of lab-grown meat, and this is due to the lack of sufficient information about lab-grown meat and how it is produced, The availability of information about the product will affect the ability of the Egyptian customer to respond to all his fears and doubts about this new product. With regard to the analysis of what customers towards lab-grown meat in Egyptian food establishments, it was found that the majority of customers are not aware of this new product and expressed their desire to know information about sensory properties in terms of (appearance, color, aroma, and texture), and nutritional and health value in terms of (fat percentage and cholesterol and its nutritional and healthy content), and the environmental properties represented in (saving water and energy and reducing environmental pollution), the religious and ethical aspect, and the cost factor, which according to the cost analysis found that the cost of production will decrease significantly soon, and thus the customer's acceptance in Egyptian food establishments depends on responding to his inquiries about this product. Finally, there is a significant impact of the dimensions of availability of sufficient information about lab-grown meat (organoleptic properties, nutritional value, environmental properties, religious and ethical aspects, and cost factor) on the ability of customers in Egyptian food establishments to experience, and experience eating lab-grown meat in the future.

Recommendations for the production of lab-grown meat in Egypt

According to the literature review and the results extracted from the field study, the following recommendations could be suggested:

1) Adopting the idea of producing lab-grown meat efficiently in accordance with the standards and specifications used for circulation and acceptance in the Egyptian market, especially the hospitality sector (hotels/food establishments, etc.), and this is a simulation of its spread all over the world such as (American countries - European Union - East Asian countries), due to its presence in Within the wishes of foreign customers soon in Egypt in hospitality establishments.

2) Permanent awareness by food science professionals for factory owners, restaurant owners, and chefs, and providing them with sufficient information about lab-grown meat.

3) Egyptian customers must be made aware of lab-grown meat through the media and institutional publicity for the sustainability and safety of food, nutrition, and health of cultured meat through the dissemination of sufficient information about lab-grown meat by food science professionals.

4) Regulatory policy should be formulated regarding the entire production process and religiously controlled meat production so that it is produced according to controls appropriate to the Muslim (halal) segment.

Limitations and Future Research

The existing study revealed a strong relationship between the use of lab-grown meat and customer acceptance and knowledge of this innovative techniques in Egyptian food establishments, which is the focus of the research. It cannot be claimed that its results are generalizable and represent the entire food industry within Egypt, which means that there are fruitful opportunities for future studies for researchers and owners of hotels and food establishments, for example, to investigate the views of restaurant owners and managers who are interested in innovative techniques for the development of food science and the readiness

of chefs in Egyptian food establishments. to deal with these food innovations. Moreover, because the information provided to the subjects of this study prior to giving their opinion was limited, some subjects were unable to express their support or objection to the issue of the intention to accept eating lab-grown meat in Egyptian food establishments. Accordingly, at this stage of theoretical development and empirical evidence, we can only partially predict the factors affecting awareness and customer acceptance in Egyptian food establishments in a longitudinal framework to provide a deeper understanding of how the decision to adopt actual lab-grown meat in Egyptian food establishments. Future research may also address the determinants and effects of the acceptance and willingness of food science regulators, chefs, and food professionals about the use and consumption of lab-grown meat within hospitality establishments within Egypt by customers.

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محددات وتوابع استخدام اللحوم المستزرعة معمليًا بمؤسسات الأغذية السياحية في مصر من وجهة نظر العملاء

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معلومات المقالة

الكلمات المفتاحية

تكنولوجيا الغذاء؛ اللحوم المستزرعة معمليًا؛ وجهة نظر العملاء؛ مؤسسات الأغذية السياحية.

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الملخص

عند استخدام مؤسسات الأغذية السياحية منتجات غذائية جديدة، فإنها ستواجه ردود فعل مختلفة وأسئلة من العملاء حول هذه المنتجات. يهدف البحث إلى معرفة مدى قبول العملاء بمؤسسات الأغذية السياحية واستعدادهم لتناول اللحوم المستزرعة معمليًا. لتحقيق هدف البحث، تم تصميم استبيان إلكتروني وتوزيعه بشكل عشوائي على عينة من العملاء بمؤسسات الأغذية السياحية، وتم استلام ٥٢٣ ردًا صالحًا للتحليل الإحصائي بواسطة **SPSS V.28**. أشارت النتائج إلى أن العملاء بمؤسسات الأغذية السياحية ليس لديهم معلومات كافية عن اللحوم المستزرعة معمليًا (الخصائص الحسية، والقيمة الغذائية، والخصائص البيئية، والجوانب الدينية والأخلاقية مقارنة باللحوم الطبيعية، بالإضافة إلى عامل تكلفة هذه اللحوم، لذلك ربما يكون قبول العملاء وثقتهم باللحوم المستزرعة معمليًا عقبة رئيسية أمام عملية تسويق هذا المنتج الجديد في مؤسسات الأغذية المصرية. بناءً على النتائج، تم اقتراح بعض التوصيات وتوجيهها إلى المتخصصين في علوم الأغذية وأصحاب المصانع وأصحاب المطاعم والطهاة والمؤسسات الغذائية. كانت إحدى تلك التوصيات أن يكون العملاء المصريون على دراية باللحوم المستزرعة معمليًا من خلال نشر المعلومات الكافية عنها من قبل المتخصصين في علوم الأغذية.