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Consumer perceptions of lab-grown cells: Awareness, barriers, and the power of information. A review

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Abstract: Lab-grown cells (also known as cell-based or cultured meat) are novel food innovations that face uncertain consumer acceptance. This review examines recent research (2020–2024) on consumer perceptions of lab-grown cells, focusing on three main areas: (1) public awareness and familiarity, (2) psychological and cultural aspects shaping perceptions, and (3) the impact of information on acceptance. Results show that the awareness of lab-grown cells varies widely across regions; in countries with high meat consumption, such as the USA and Australia, or where culinary delights are highly valued, such as France, respondents rated lab-grown cells lower than in those countries where meat consumption is now rising, for example, China or Mexico. The knowledge of lab-grown cells positively impacted attitude, while psychological barriers (e.g. food neophobia) and disgust emerged as key deterrents. The information provided to respondents significantly influenced their willingness to accept, buy, try, eat, and pay premium prices. Personal (mainly health-related) benefits significantly increased the acceptance of lab-grown cells, while societal benefits (e.g. benefits to the environment or animal welfare) had less prominent effects than expected. At the same time, information regarding production technology (high-tech, laboratory, artificial) resulted in lower ratings from respondents. The conclusion is that overlooking the positive attributes of meat and focusing on the unproven advantages of lab-grown cells may lead to misleading results. On the other hand, effective communication – especially messages highlighting personal benefits – can substantially improve the consumer openness.

Keywords: cultured meat; meat; opinion; respondents; willingness

INTRODUCTION

Meat played a key role in human brain development (Mann 2018), and remains crucial for pregnant and lactating mothers, children, teenagers and seniors (Leroy et al. 2023). The role of meat in nutrition goes far beyond providing food with mass energy, or even protein (Leroy et al. 2023): it is a valuable source of high biological value protein, iron, vitamin B12 and other B vitamins, zinc, selenium and phosphorus (Boateng et al. 2020), as well as a source of essential nutrients, including protein, fatty acids, trace elements, and vitamins (Dalle Zotte and Szendro 2011), some of which cannot even be found in plant-based sources (Ede 2024). However, views are spreading in social media claiming that long-term consumption, especially of processed red meat, increases the risk of total mortality, cardiovascular disease, colorectal cancer, and type 2 diabetes (Richi et al. 2015), despite the

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most recent scientific literature refuted such assumptions (Johnston et al. 2023). One result is that vegetarianism and veganism are spreading, especially among young people (Salehi et al. 2023). Many researchers agree that meat is part of a healthy diet (Giromini and Givens 2022); at the same time, there is broad consensus that meat consumption in Western diets should be reduced (de Boer and Aiking 2017) due to general overconsumption and its link to metabolic diseases and other health issues. Some consumers are willing to reduce their meat consumption due to the environmental (Zimmerman 2024) or emotional reasons (Pluhar 2009). However, many meat eaters refuse to reduce their meat consumption (Dagevos 2021).

Additionally, new issues have emerged around animal husbandry, particularly concerns about its role in global warming and the production of greenhouse gases (Gerber et al. 2013). While it is often linked to high greenhouse gas emissions and heavy land and water demand, these impacts have decreased significantly in recent decades (Capper et al. 2009; Balazs et al. 2023; Szendro 2024).

Due to the expected protein shortage and food sensitivities, as well as the concern related to animal husbandry, intensive research and development have been initiated in the field of meat substitute products in recent years (Fatima et al. 2023), and alternative protein sources, such as plant-based meat substitutes, insect protein, algae, or lab-grown cells, have already appeared on the market, and more will likely appear in the future. The reasons and justifications for this are provided in many ways. These include the continuous growth of the Earth's population and their supply with sufficient quantity and quality of food and protein, animal protection, the role played by animal husbandry in global warming, CO_2 and methane emissions, land and water use, animal welfare (Godfray et al. 2018), and the reduction of livestock due to these reasons, the aversion to slaughtering animals.

Start-up companies are looking for a solution for meat replacement (Fatima et al. 2023). Among the meat substitutes, in principle, lab-grown cells – meat cultivated from animal cells in a laboratory setting – have been proposed as an alternative to meat and are the most similar to meat. It appears in the literature under several names: in addition to lab-grown cells, cultured meat, cultivated meat, artificial meat, synthetic meat, laboratory meat, lab-grown meat, *in vitro* meat, vat-grown meat, cell-based meat, cell-cultured meat, animal-free meat, slaughter-free meat, healthy meat, clean meat (FAO 2022). Despite its most common names, it does not correspond to the concept of meat either (Leroy and Praet 2015; Lee et al. 2020). Each name brings the lab-grown cells acceptance closer to or further away from consumers. Names such as *in vitro* or lab-grown cells emphasise the production process, the unnatural production, which evokes a negative feeling in people (Siegrist et al. 2018). In this regard, clean meat resulted in a more favourable opinion (Bryant et al. 2019a).

The lab-grown cells market is still in its early stages, but scientific progress and business interest in this field have been rapid. So far, 3.1 billion US dollars has been invested in cultivated meat and seafood companies (Good Food Institute 2024). The first regulatory approvals for sales have occurred in recent years (in Singapore, the USA, and Israel), but several institutions predict a promising future for laboratory-produced products. According to optimistic forecasts, the *in vitro* cultured cells market will reach 25 billion US dollars by 2030, and its market value is predicted to be between 200 and 800 billion dollars by 2050 (Statista 2024b). While several experts predict a bright future for these products, some European countries (Italy, France, Hungary, and Austria) wish to ban their production and distribution (Hocquette et al. 2025), citing human health and environmental protection, sustainable agricultural production and traditional countryside (Kirby 2023; Farkas 2024). However, not all potential benefits listed in connection with lab-grown cells (reduction of the environmental impact of meat production, its impact on climate change, animal welfare, food safety, and human health) seem to be well-founded (Mattick 2018; Ellies-Oury et al. 2022; Pontalti et al. 2024; Risner et al. 2025). Recent techno-economic assessments and cradle-to-gate life cycle assessments show that lab-grown cells may not offer clear environmental advantages over meat production (Risner et al. 2025).

Besides, the widespread consumer acceptance of lab-grown cells remains a major uncertainty. Since lab-grown cells are novel and are available in very few places, the opinions are not based on consumer experience, only on the knowledge they could read or watch about it on TV or social media or their bias (Pilarova et al. 2022). Therefore, only hypothetical choice experiments can be done

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at the moment. Nevertheless, collecting the opinions published in the literature regarding lab-grown cells is important. In the case of any new product or novel food, it is advisable to start assessing consumer attitudes at the initial stage; before commercialisation, it is worth getting to know these results and opinions and using them already in the development stage.

Investigating the consumer perception of lab-grown cells is a hot topic at the industrial, political, and social levels (Pakseresht et al. 2022; Deliza et al. 2023; Lewisch and Riefler 2023). Previous reviews (e.g. Bryant and Barnett 2020; Mancini and Antonioli 2020) provided a broad overview of consumer attitudes towards lab-grown cells. The present review offers novel insights by specifically focusing on different types of information, such as technical details, benefit-driven messages, etc., that influence consumer perceptions and acceptance of lab-grown cells. This approach fills a gap in the literature and updates prior findings with recent data.

The review is structured as follows: Chapter 2 examines consumer awareness and familiarity with lab-grown cells – how much consumers know about this type of product and how that baseline influences their behaviour; Chapter 3 analyses what factors (neophobia, cultural aspects, framing and the level of any type of information) shape consumer perceptions; and Chapter 4 compares the acceptance of lab-grown cells versus meat and reviews the willingness across different countries, as well as the influence of information – how different information (technological and added benefits) affects consumer willingness to accept, try, buy, or pay for these products.

CONSUMER AWARENESS AND FAMILIARITY WITH LAB-GROWN CELLS

Consumer awareness of lab-grown cells is the first step in the decision process: consumers must know the product exists before they can form an opinion or consider trying it. Familiarity goes a step beyond awareness – it is about how well consumers know the concept of lab-grown cells. Survey results indicate that awareness levels and familiarity differ significantly by region. In general, public knowledge is growing but remains far from universal. This Chapter examines consumer awareness and familiarity in key regions (Europe and Asia) where most studies have been conducted.

According to Chinese authors, the percentage of those who know about lab-grown cells ranges from 66% to 90%. In the study by Zhang et al. (2020), nearly 90% of those surveyed heard of lab-grown cells, although detailed understanding was low (only 11% knew its exact meaning). According to Ortega et al. (2022), 65% of Chinese heard of lab-grown cells. In the article by Min et al. (2024), 66% of the respondents heard of lab-grown cells. Dempsey and Bryant (2020) only reported a value of 40%. In China, lab-grown cells are referred to by different names. Most respondents who heard about it (70%) knew what it meant (33%) and they knew it was artificial meat. The values were 30% and 14% for cultured meat and 21% and 11% for cell-based meat (as mentioned in the survey), respectively (Li et al. 2023). The familiarity with these products among Asian residents in Singapore was low; only a few respondents were very familiar, while the slightly familiar category reached only 24% (Chia et al. 2024). In the USA, 43% of the respondents heard of lab-grown cells, 38% were a little familiar, 15% were moderately familiar, 8% were familiar, and 1% were very familiar with the concept of lab-grown cells (the study called the product "clean meat") (Baumann and Bryant 2019). Familiarity with lab-grown cells was higher in India and China than in the USA, where 57% of the respondents were unfamiliar with it, and only 11% were very familiar. In China and India, 35% and 25% of respondents were not familiar with lab-grown cells, respectively, while the proportion of those who were very familiar was 30% and 39%, respectively (Bryant et al. 2019b).

In Western European countries, awareness tends to be lower. In Belgium, lab-grown cells are referred to by three different names: cultured, *in vitro*, and synthetic meat, which 55%, 40%, and 45% of respondents heard of, and 28%, 23% and 29% knew them, respectively (Verbeke et al. 2021). In a previous study (Verbeke et al. 2015b), 49% of Belgians (Flemish) heard of lab-grown cells, but only 13% knew what it meant. In Germany, estimates vary. Even though news channels, especially social media, deal a lot with lab-grown cells, in one survey, 23% of respondents were aware of it and had some knowledge (Bryant et al. 2020). In another study, 22% of students heard of lab-grown cells, another 22% knew what it meant, while 56%

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had no knowledge at all (Dupont and Fiebelkorn 2020). In a study carried out among a broader population, 32% of the respondents had information about lab-grown cells and knew what it was, and another 38% heard of it but they did not know what it meant (Dupont et al. 2022). According to the study of Heijnk et al. (2023), 46% of the participants already heard of lab-grown cells. Most German people learned about it from television (54%) and the Internet (51%). Newspapers and trade magazines (22%) and friends and acquaintances (12%) represent a smaller proportion (Dupont et al. 2022). Slovenians (73%) are more aware of lab-grown cells than those from the UK (40%) (Rehman et al. 2024). The lowest awareness (16%) was recorded among the French, who still firmly adhere to their eating traditions (Bryant et al. 2020).

Awareness of lab-grown cells is still emerging. Regions like East Asia show higher public familiarity due to their interest in food technology, while many Western European consumers remain relatively unaware. Awareness and familiarity with meat alternatives influence the decision process and consumer attitudes towards lab-grown cells. Respondents with prior knowledge of such products had a more favourable attitude towards them and were more likely to consider lab-grown cells a good substitute for meat than those who had never heard of them (Heijnk et al. 2023). Still, consistent, clear terminology is needed to truly measure and improve awareness.

FACTORS SHAPING CONSUMER PERCEPTIONS

Even when consumers are aware of and familiar with lab-grown cells, various factors influence their perception of them. These factors can be psychological (individual feelings and thoughts) or social/cultural (shared norms and values). In this Chapter, major barriers (neophobia and disgust) and drivers (ethical, environmental concerns, or curiosity) will be discussed.

Psychological barriers: Food (technology) neophobia, disgust

Most individuals harbour reservations about the new, particularly regarding new food (Gunden et al. 2024). These concerns are amplified when the new food is produced using a new, unfamiliar technology (Hocquette et al. 2015; Siegrist et al. 2018). In cases of extreme aversion, food neophobia and disgust may arise, as evidenced in some responses (Wilks et al. 2019; Rosenfeld and Tomiyama 2022; Baum et al. 2023; Li et al. 2023). Research has indicated that lab-grown cells have fostered negative associations among many consumers (Siegrist and Hartmann 2020), mainly due to concerns about naturalness (Siegrist et al. 2018; Siegrist and Sutterlin 2017), safety compared to meat (Krings et al. 2022), food technology and food allergy (Rombach et al. 2022). The higher the food phobia, the lower the intention to try and consume lab-grown cells (Baum et al. 2023).

Participants with higher levels of food neophobia were more disgusted by it than those with lower levels of food neophobia (Siegrist et al. 2018; Hamlin et al. 2022).

Food neophobia is closely related to aversion to lab-grown cells in almost all countries. French respondents were most disgusted by such a product, while Mexicans were the least. One reason for the lower acceptance in France may be rooted in their strong food traditions. In contrast, countries with more diverse food cultures (e.g. Mexico or England) tend to be more open to new foods. Food neophobia in India was higher than in the USA and China (Bryant et al. 2019b). In the USA, 41% of respondents reported some level of disgust toward lab-grown cells: a little (24%), moderately (6%), quite a bit (6%) and extremely (5%) (Baumann and Bryant 2019). Similarly, 35% of UK and US omnivorous respondents considered lab-grown cells too disgusting (Rosenfeld and Tomiyama 2022). Interestingly, the perception of lab-grown cells also varies depending on how much it reminds respondents of real animal products. For vegetarians in the UK and USA, the more the product seemed animal-like, the greater their disgust. However, for omnivores, the same characteristics reduced disgust (Krings et al. 2022; Rosenfeld and Tomiyama 2022). Hence, lab-grown cells' resemblance to meat can either increase or decrease disgust, depending on the person's diet. Respondents who found lab-grown cells disgusting were less willing to try them and perceived more risk (Verbeke et al. 2015a; Egolf et al. 2019). Some people believe that lab-grown cells are genetically modified, made with chemicals, and driven more by profit than health benefits.

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Emotions also play a key role in the perception that lab-grown cells are unnatural. On the other hand, curiosity about food and the perception of lab-grown cells as a realistic alternative to meat have positively influenced consumers' willingness to try lab-grown cells (Rombach et al. 2022). The proportion of those US respondents who were anxious about lab-grown cells was higher than the disgust at 36%, 14%, 10% and 6%, respectively (total: 66%) (Baumann and Bryant 2019).

Overall, food neophobia seems to be a core challenge in introducing lab-grown cells to consumers.

Cultural and societal influences

As seen in the previous chapter, cultural factors significantly influence consumer perceptions of lab-grown cells. Acceptance of such products varies across societies based on dietary traditions, culinary values, religious beliefs, and general attitudes towards technology.

The first multi-country survey took place 20 years ago. According to a study published in 2005 (Eurobarometer 2005), the population of the EU25 was sceptical about lab-grown cells. To the statement "Growing meat from cell cultures so that we do not have to slaughter farm animals", 6% of the respondents answered "In all circumstances", 18% answered "Only if it is highly regulated and controlled", 12% "Only in exceptional circumstances" and the majority, 54% "Never". Siegrist and Hartmann (2020) surveyed respondents in ten countries about the acceptance of lab-grown cells. Acceptance was the highest in Mexico (56%), followed by South Africa, England and Spain (50–53%). Moderate acceptance was observed in Sweden, China, Australia, the USA, and Germany (45–48%), while France had the lowest acceptance (38%). Despite of their low acceptance level, most French respondents anticipate that lab-grown cells will become widespread in the long term (Gousset et al. 2022). However, new products and foods spread slowly in countries like France, which have strong traditional values. Similarly, Italian consumers tend to favour local and traditional foods (Laroche et al. 1998). Klockner et al. (2022) examined the opinions of Norwegian, Danish and Finnish people regarding the acceptance of cultured proteins (together with lab-grown cells, fish and milk). Norwegians demonstrated average acceptance, Danes were slightly below the average, and Finns slightly above. This variation may be explained by Finnish consumers' greater familiarity with food technology, influenced by recent media exposure.

Despite limited research, acceptance of lab-grown cells is higher in China, India, Mexico, and South Africa, where living standards and meat consumption have only recently begun to increase, than in the USA, Australia, Sweden and especially in France, where meat consumption has a tradition and is also a culinary delight. In Australia, China and the UK, the lack of need for various protein alternatives was a common phenomenon among highly reluctant consumers. Ratios of extremely unwilling responses to adopt lab-grown cells were the highest in Australia (69%), reaching 19% in the UK, while it was the lowest in China (12%). The exact figures against reducing meat consumption were 73%, 18% and 9%, respectively, in the three countries (Ford et al. 2024). This is because meat consumption is deeply embedded in Australian cultural norms, which makes them more resistant to changing their meat consumption behaviour (Ford et al. 2024). There are concerns about masculinity and the belief that the consumption of lab-grown cells is contrary to national pride and tradition associated with producing high-quality animal meat (Ford et al. 2023). In contrast, China has a long history of consuming meat substitutes such as tofu, so consumers are more open-minded to accept new products such as lab-grown cells. Besides, in China, people often buy pieces or minced meat; hence, the format of meat used in Chinese cooking may be more suitable for lab-grown cells (Dempsey and Bryant 2020).

Religion can also influence perception. Examining three Asian ethnic groups living in Singapore, Chia et al. (2024) found that the Chinese were more likely to consume lab-grown cells, the Malays were less likely to consume it, and the Indians were somewhere in between. The Malays emphasised the religious reason for their decision since they are predominantly Muslims.

Overall, cultural and social context acts as either headwinds or tailwinds for consumer perceptions. They can amplify fears (if the culture tends to see lab-grown cells as a threat to tradition), or reduce barriers (if the culture sees such products as an exciting opportunity or necessary innovation). The significant differences between cultures indicate that the consumer acceptance of emerging food

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technologies cannot be generalised across countries. Meat substitutes can be better integrated into the diet of those countries that accept them more favourably.

Framing effects: Positive versus negative information

In addition to psychological factors and cultural and social influences, how information on lab-grown cells is presented may also affect consumer perceptions. Consumers may receive the same basic facts but they form completely different impressions depending on how those facts are framed.

After receiving positive information (positive framing) about lab-grown cells, the unfamiliar participants increased their scores more than the familiar ones. The results prove that the opinions of those unfamiliar with lab-grown cells can be significantly influenced by the given information like in the familiar group. Compared to the pre-survey opinions, exposure to positive information resulted in higher scores across all familiarity groups: 1.26, 0.64 and 0.58 points higher with increasing awareness levels, respectively. On the other hand, exposure to negative information led to a comparable decline in scores, with decreases of –1.25, –0.44 and –0.67, respectively (Becker et al. 2017b).

The opinion of Dutch university students about lab-grown cells was also investigated. Becker et al. (2017b) provided respondents with positive and negative information: for properties, good versus bad (e.g. for the environment), low versus high (e.g. energy use), pleasant versus unpleasant, better versus worse, less versus more, or fortunately versus unfortunately. They divided the respondents into three groups based on their attitude towards lab-grown cells: unfamiliar, a little bit familiar and familiar. Compared to the opinions before the test, if the respondents received positive information, the scores in the three groups were higher by 1.26, 0.64 and 0.58, respectively. On the other hand, if they received negative information, a similar decrease can be observed: the value of the scores decreased by –1.25, –0.44 and –0.67, respectively.

In a German study, Baum et al. (2021) provided respondents with less (simple) and more (complex) positive and negative information. There was no difference in implicit attitudes between the four groups. A significant difference emerged in the explicit attitudes; in the negative-complex, negative-simple, positive-simple and positive-complex groups, they were 3.46, 4.04, 4.86 and 5.03, respectively (on a 1–7 Likert scale). There was a significant difference between negative and positive information in trying lab-grown cells: 3.29, 3.70, 4.65 and 4.74, respectively. Based on this study, the difference in explicit attitude and purchasing evaluation between negative-complex and negative-simple is more remarkable than between positive-complex and negative-positive, which shows that negative information has a more significant impact on people's decisions than positive information. Negative information also increased the level of neophobia.

Based on the results, the acceptance of lab-grown cells can be increased or decreased with equal effectiveness, depending on whether positive or negative information is presented to the participants.

Influence of the level and type of information

Consumer opinions about lab-grown cells are significantly influenced by their knowledge and the information (if any) they receive when completing questionnaires.

Customers' uninfluenced opinions can be known if they do not receive any information that would influence their opinion or purchase intention. The results of German research show that attitudes towards lab-grown cells are rather negative and considered unfavourable (Heijnk et al. 2023). Most respondents reject such products, and 28% of those who accept it would try it. Only 6% of the respondents considered lab-grown cells an alternative to meat. Part of the reason for this is that they currently have no experience with consuming this meat alternative. According to the Irish, lab-grown cells are an unnatural and artificial product (Shaw and Mac Con Iomaire 2019). According to the Chinese, negative opinions about lab-grown cells include harmful nutritional effects, profit-driven foreign companies and poor taste compared to meat (Wang 2022). According to Rasmussen et al. (2024), most people in the Nordic countries believe that lab-grown cells are more than a futuristic food.

The results show that the respondents have a rather negative attitude towards lab-grown cells if they have no prior information about them.

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Analysing the issue further, studies with no or minimal information can be compared with scenarios in which different details are given. For this reason, a distinction is made between technical, additional, and extra information based on the following criteria.

When respondents fill in a questionnaire, they receive different types of information about lab-grown cells. Providing technological information/explanation (Tech info) on what lab-grown cells are and how they are made usually helps consumers understand the concept from the technological point of view. One such example could be Verbeke et al. (2021) formulation: lab-grown cells are "*produced in a laboratory. Their production goes as follows. First, muscle tissue is taken from an animal. Next, stem cells are extracted from this tissue. These stem cells are then cultured to become muscle cells; they are grown under stress to increase in size and mass. This yields meat produced without further involvement of an animal.*"

An interesting condition is when the respondents receive additional (benefit) information (Add info) about the advantages of lab-grown cells compared to meat. This highlights both the personal benefits (such as the same appearance, taste, smell, texture and nutrients like in meat, as well as potential health benefits) and the societal benefits (including improved animal welfare, elimination of the need to slaughter animals, and a reduced environmental footprint through lower greenhouse gas emissions, land and water use compared to meat production).

In some studies, researchers provide extra information (Extra info), such as reducing saturated fatty acids and increasing the proportion of omega-3 fatty acids enriched with specific vitamins and the most essential minerals, thus increasing the nutritional value of lab-grown cells. These concepts will be referred to later.

Opinion based on technological information. Production technology plays a crucial role in the case of novel foods, such as lab-grown cells. This is primarily due to its association with terms such as "laboratory", "artificial", and "*in vitro*", which not only serve as indicators but also appear in product labelling across various contexts. A significant number of people distrust new technologies and production methods. Since there is only sketchy knowledge of the production of lab-grown cells, a negative opinion can also be formed regarding the new food.

After receiving an explanation of the production technology (Tech Info), Belgian respondents expressed a negative opinion on lab-grown cells. Specifically, 65% regarded it as unnatural, 58% did not perceive it as meat, 51% expressed a lack of trust in it, and 38% indicated they did not perceive a need. A similar proportion (38%) held an opposing view. Additionally, 26% found the technology ethically acceptable, and only 5% considered it healthy. Only 16% of the respondents trusted in lab-grown cells. Many respondents considered them unnatural, while a few considered them healthy. At the same time, the consumers evaluated them positively regarding animal welfare and the environment. According to participants provided with Tech information, some of the most important concerns regarding the acceptance of lab-grown cells include safety, health and nutrition concerns, as well as concerns about the loss of agricultural jobs and traditions, the view that lab-grown cells are disgusting, and being unnatural. Unnaturalness is primarily related to manufacturing (Wilks et al. 2021).

When the production technology was briefly explained to Canadian consumers, 69%, 27%, and 13% of them would choose a beef burger, a plant-based burger and a cultured burger, respectively. The vast majority thought the beef burger would be the best (90%), followed by plant-based (56%) and lab-grown hamburger (41%). Only 4% of the respondents believed that a lab-grown cell-based burger would taste the best (Slade 2018). It is no coincidence that only 13% of them would be willing to buy it.

At the same time, some people are more accepting, curious, and receptive to new things, like new technology, and are not so averse to lab-grown cells. Consumers in the Nordic countries, who received only technological information, had a neutral or slightly positive attitude towards cultured protein products such as lab-grown cells, fish or dairy products. Environmental benefits are the most significant positive impact; lab-grown cells are also considered cheaper, healthier, more nutritious, better value for money, and more ethical, and it is believed to contain more vitamins and minerals than meat (Klockner et al. 2022).

After learning about the production of lab-grown cells, the German students' attitude to lab-grown cells was 2.31 on a scale of 1–5, and 3.30 to lab-grown burgers (Dupont and Fiebelkorn

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2020). According to the students, artificial vs natural comparison, as shown by the score of 1.20 given on a scale of 1–7 (average: 3.00), lab-grown hamburgers were considered artificial. The following statement pairs were evaluated as follows: not interesting vs interesting (4.29), environmentally harmful vs friendly (4.12), unhealthy vs healthy (3.06), dirty vs clean (3.61), unhygienic vs hygienic (3.57), disgusting vs delicious (3.22) comparison. According to most respondents, lab-grown cells do not carry any harmful toxins or microbes, and do not increase the risk of infectious disease. Their opinion of lab-grown cells and cultured burgers on a scale of 1–5 was 2.31 and 3.30, respectively (Dupont et al. 2022).

According to US respondents who received technical information, the most significant obstacles to accepting farmed meat are food and hygiene, disgust sensitivity and food neophobia (Wilks et al. 2019).

Siegrist et al. (2018) compared the acceptance of lab-grown cells-technical (biotechnology, artificial, environment-friendly, similar to meat), lab-grown cells-nontechnical (tissue cultivation, artificial, environment-friendly, less animal suffering) and meat (negative impact on environment and animal). Participants proposed lab-grown cells as a more environmentally and animal friendly alternative to meat production. However, if the participants received information that the lab-grown cells were produced using biotechnology methods, they would choose meat despite its negative environmental effects.

In most cases, exposure to information about lab-grown cells production technology leads individuals to form a rather negative image of the product; consumers may even develop an aversion to them.

Opinion based on additional (benefit) and extra information. After reading the Tech info about lab-grown cells, respondents usually form a negative opinion on them. However, from a marketing perspective, researchers aim to get a favourable impression of lab-grown cells. To achieve this, Tech info is often followed by an additional statement (Add info) emphasising that lab-grown cells are the same as meat, or highlighting their social and/or personal benefits. All this information influences the respondents' opinions to varying degrees.

When respondents received additional information about lab-grown cells, their acceptance improved (Bryant et al. 2020). In the study of Hocquette et al. (2015), the most significant impact was given to the information that lab-grown cells are antibiotic-free. This was followed by an improvement in animal welfare and a reduction in environmental impact. The proportion of the respondents who favoured lab-grown cells was between 20% and 40%. The educated French people were introduced to the problems of animal husbandry and were given detailed information on the development of lab-grown cells. According to the opinion of most respondents, producing lab-grown cells is a feasible and realistic goal. German respondents were more positive about accepting lab-grown cells than the French. The fact that lab-grown cells are antibiotic-free had the most considerable effect, which was given by 74% and 64% in the two countries, respectively. The reduction in animal welfare, environment, and pathogen risk reached 66–67% for the Germans and 53–54% for the French (Bryant et al. 2020).

Mancini and Antonioli (2020) investigated how information about lab-grown cells affects their acceptance in Italy. The respondents gave higher scores (on a 1–5 scale) to positive externalities (3.1–3.5) and lower scores (2.4–2.8) to intrinsic attributes. If more information was received (environmental, health and food safety benefits, greenhouse gas emissions, water and land use) in addition to the technical information, the previous scores were increased by 0.2–0.3 (positive externalities) and by 0.3–0.5 (intrinsic attributes).

In the study by Siegrist and Hartmann (2020), participants from several countries received Add info (environmentally friendly, lower suffering of animals, taste comparable to meat) and Tech info. As a result, the acceptance of lab-grown cells was between 38% and 56%.

Chinese and Belgian respondents believe that lab-grown cells have the same taste, texture and nutritional content as meat (Bryant and Sanctorum 2021; Li et al. 2023). Belgian respondents would often choose lab-grown cells instead of meat to avoid animal suffering, minimise environmental impacts and feed the global poor. At the same time, the most frequently listed obstacles are price, lack of trust, and unnaturalness compared to meat. Answers also appeared that lab-grown cells are a commercial stunt; they are worried about farmers and the loss of rural traditions. Respondents who said meat substitutes did not meet their needs often cited

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taste and texture as the main reasons (Bryant and Sanctorum 2021).

Dutch, Chinese, and Ethiopian graduate students received additional information that lab-grown cells have a small environmental footprint, are free of risk of diseases, and do not have any animal welfare problems. Lab-grown cells were associated with the same physical properties and content as meat, yet they were not considered meat (Becker et al. 2017a). Respondents regarded lab-grown cells as the technology of the future and not meat, and associated lab-grown cells with fake, unnatural, and non-organic more often than Chinese participants. At the same time, students from all three countries associated them with high technology.

After receiving Tech and Add information (same taste, texture, and the same or better nutritional content), the most common words and concepts about lab-grown cells used by US adults were as follows: artificial 15% (fake, unnatural, artificial), science 11% (scientific, laboratory, chemicals), positive 10% (good, awesome, super), natural 8% (natural, no hormones, unprocessed), unusual 7% (weird, strange, different) (Bryant and Dillard 2019). As the list shows, negative (lab-grown cells are unnatural) and positive (lab-grown cells are natural) adjectives also apply to this product according to the respondents.

In addition to the Tech info, Belgian respondents received much additional information about the environmental and health benefits of lab-grown cells and even about the increased omega-3 fatty acid content, as extra information (Extra info). The respondents considered lab-grown cells as a substitute for meat, as it is a good, feasible, acceptable, effective and long-term solution, as they scored more than four on a scale of 1–7 for each attribute (4.35–4.84) (Verbeke et al. 2015b), where the long-term solution received the highest value.

An interesting study by Rolland et al. (2020) showed how the opinion changes when the Dutch respondents received different information. Before giving any information, the acceptance of lab-grown meat was similar in all groups (10.1–10.7 on a scale of 3–15), significantly improving after the information. One group of participants was informed about the social benefits of lab-grown cells (less greenhouse gases, animal suffering, land, water and energy use), and another group received information about the personal benefits (the same as meat, neither antibiotics nor hormones, healthier). In contrast, the third group was informed about the quality of lab-grown cells (the same taste, odour, tenderness, etc.). The acceptance of lab-grown cells improved significantly after each information session. If the participants received information about societal benefits, acceptance increased by one score; if they received information about personal benefits, acceptance increased by 1.6; hence, in the case of personal benefits, the information increased the acceptance of lab-grown cells slightly more than in the case of societal benefits.

The results show that the respondents' opinions can change significantly depending on the information received. Additional (benefit) and extra information can offset the negative impact of Tech info and even lead to the higher acceptance of lab-grown cells. Generally, the more favourable information the participants receive, the greater their level of acceptance.

WILLINGNESS TO ACCEPT, TRY AND PAY MORE FOR LAB-GROWN CELLS

Ultimately, beyond attitudes, the key question is whether consumers would accept lab-grown cells over meat and buy and consume lab-grown cells once they are available. Current data on willingness (willingness to try – WTT, willingness to buy – WTB, willingness to pay more – WTP) gives insight, but it is inherently hypothetical until products are on the market. However, it helps us indicate how close consumers are to actual adoption.

Relative acceptance of lab-grown cells versus meat

This sub-chapter shows how consumers perceive lab-grown cells compared to meat.

Articles where readers can get to know opinions about meat and lab-grown cells are infrequent. Slade (2018) asked for opinions about beef, organic meat, and lab-grown cells (burgers), providing Tech information. Beef had the highest acceptance, followed by organic and lab-grown cells, with a much smaller value (Table 1). In Europe, lab-grown cells acceptance was higher among Germans than among French respondents (Bryant et al. 2020). The difference was 14%, 19% and 19% in WTT, WTB and willingness to eat them instead

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Table 1. Willingness towards lab-grown cells

Origin	Information	Unit	WTA	WTT	WTB	WTS	WTP	Authors
Canada	Beef	%	–	–	69	–	–	Slade (2018)
Canada	Organic	%	–	–	50	–	–	Slade (2018)
Canada	Lab-grown cells Tech info (burgers)	%	–	–	13	–	8	Slade (2018)
Germany	Tech info + the same as meat	%	–	58	56	53	–	Bryant et al. (2020)
France	Tech info + the same as meat	%	–	44	37	34	–	Bryant et al. (2020)
International students	Tech info	%	–	–	19	–	–	Hocquette et al. (2015)
French students	Tech info	%	–	–	9	–	–	Hocquette et al. (2015)
China	Basic info: Tech + Add info (the same taste, texture and nutrients) Lab-grown cells	mean %	–	3.26 47	2.98 32	34	2.38 32	Li et al. (2023)
China	Basic info Lab-grown cells	mean	–	3.01	2.72	30	2.16	Li et al. (2023)
China	Basic info Lab-grown cells	mean %	–	3.23	2.94	33	2.34	Li et al. (2023)
China	The three groups pooled	mean % %	–	3.16 11[1] 33[2]	2.88 5[1] 27[2]	–	2.29 2[1] 10[2]	Li et al. (2023)
China	Cognition No	%	36	44	32	–	–	Min et al. (2024)
China	Cognition Yes	%	49	54	42	–	–	Min et al. (2024)
China	No positive information (no specific information about lab-grown cells received)	%	31	40	29	–	–	Min et al. (2024)
China	Tech + Add positive info (the same as meat, healthy, save land and water, reduce GHG)	%	60	63	49	–	–	Min et al. (2024)

[1]Extremely likely; [2]Somewhat likely

GHG = greenhouse gas; WTA = willingness to accept; WTB = willingness to buy; WTP = willingness to pay a premium price; WTS = willingness to substitute lab-grown cells for meat; WTT = willingness to try

of meat, respectively (Table 2). Although the vast majority of the French and international educated consumers agree that the meat industry (animal husbandry) is facing problems of environmental degradation and animal welfare, a small proportion of respondents would be willing to buy lab-grown cells (Hocquette et al. 2015) (Table 1). Swiss respondents accepted meat at twice the average WTB (willingness to buy) and WTE (willingness to eat) of the two lab-grown cells groups (Siegrist et al. 2018) (Table 3). Bryant et al. (2019b) compared the acceptability of lab-grown cells with different positive information to meat, which was described as unnatural (Table 2). Nevertheless, meat received the highest WTT (willingness to try) and WTB score. The respondents believe lab-grown cells are

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Table 2. Willingness towards lab-grown cells in different countries

Origin	Information	Unit	WTA	WTT	WTB	WTE	Authors
Denmark	Tech info	%	–	58	–	28	Rasmussen et al. (2024)
Norway	Tech info	%	–	58	–	28	Rasmussen et al. (2024)
Finland	Tech info	%	–	65	–	37	Rasmussen et al. (2024)
Brazil	No info	%	–	–	12	–	Gomez-Luciano et al. (2019)
Dominican Republic	No info	%	–	–	16	–	Gomez-Luciano et al. (2019)
United Kingdom	No info	%	–	–	20	–	Gomez-Luciano et al. (2019)
Spain	No info	%	–	–	42	–	Gomez-Luciano et al. (2019)
United Kingdom	Tech + Add info (reduced animal suffering and greenhouse gases, a new source of proteins)	%	64	–	–	–	Ford et al. (2023)
China	Tech + Add info	%	63	–	–	–	Ford et al. (2023)
Australia	Tech + Add info	%	38	–	–	–	Ford et al. (2023)
China	Tech + Add info (the same as meat, benefits to human health, environment, and animal welfare)	mean %	–	–	3.52 59	–	Bryant et al. (2019b)
India	Tech + Add info	mean %	–	–	3.52 56	–	Bryant et al. (2019b)
USA	Tech + Add info	mean %	–	–	2.72 30	–	Bryant et al. (2019b)

WTA = willingness to accept; WTB = willingness to buy; WTE = willingness to eat lab-grown cells; WTT = willingness to try

not competitive with meat, even if given a particularly negative image.

At the same time, the acceptance of lab-grown cells increased due to the negative information about meat. An example of influencing consumers' opinions was shown by Siegrist et al. (2018). The message "meat is unnatural" showed a significantly higher willingness to pay (WTP) for lab-grown fish sticks, a slightly higher WTP for lab-grown chicken nuggets, a non-significantly higher willingness to pay for lab-grown beef hamburgers, and a higher likelihood to pay more for lab-grown cells than in the control group. While the Chinese are willing to pay an average of 8.6 EUR for pork, they would pay only 7.1 EUR for lab-grown pork (Ortega et al. 2022). This means they are unwilling to pay a higher price for it.

The results indicate that the respondents accept meat significantly more than lab-grown cells. However, the acceptance of such products increases significantly when positive information is presented alongside.

Willingness to accept, buy, try, and eat lab-grown cells across different countries

Comparing consumers' perceptions in three Scandinavian countries, Rasmussen et al. (2024) found that although WTT and WTE were high in all

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Table 3. Willingness towards lab-grown cells (Tech info)

Origin	Information	Unit	WTA	WTT	WTB	WTE	WTS	WTP	Authors
China	Cognition No	%	36	44	32	–	–	–	Min et al. (2024)
China	Cognition Yes	%	49	54	42	–	–	–	Min et al. (2024)
China	No positive information (no specific information about lab-grown cells was received)	%	31	40	29	–	–	–	Min et al. (2024)
China	Tech + Add positive info (the same as meat, healthy, lower land and water use, GHG reduction)	%	60	63	49	–	–	–	Min et al. (2024)
Switzerland	Meat	%	–	–	51	57	–	–	Siegrist et al. (2018)
Switzerland	Tech (produced by tissue cultivation) + Add info (environment-friendly, less animal suffering)	%	–	–	32	35	–	–	Siegrist et al. (2018)
Switzerland	Tech (produced using biotechnology) + Add info (environment-friendly, lower animal suffering)	%	–	–	23	27	–	–	Siegrist et al. (2018)
Germany students	Photo of a burger	mean %	–	2.39	–	1.93 56	1.47	–	Dupont and Fiebelkorn (2020)
Germany	Tech info	mean %	–	3.53 57	–	2.91 30	2.97 31	–	Weinrich et al. (2020)
Germany	Tech info	%	–	23	–	–	–	–	Heijnk et al. (2023)
Germany	Tech info (burgers) 1–7 Likert scale	mean %	–	4.88 65	4.06 49	4.84 58	4.08 47	–	Dupont et al. (2022)
USA	Tech info	% %	–	31[1] 34[2]	–	6[1] 26[2]	7[1] 24[2]	1[mm] 15[sm]	Wilks and Phillips (2017)
USA	Tech info	mean	–	–	–	2.91	–	–	Wilks et al. (2019)

[1]Definitely yes; [2]Probably yes; [mm]Much more; [sm]Somewhat more

WTA = willingness to accept; WTB = willingness to buy; WTE = willingness to eat; WTP = willingness to pay a premium price; WTS = willingness to substitute lab-grown cells for meat; WTT = willingness to try

three countries, the Finns accepted lab-grown cells more than the Danes and the Norwegians (Table 2).

The consumer perception of European and non-European countries was also examined. According to a four-country survey, 12% of Brazilian respondents were willing to buy (WTB) lab-grown cells. A higher proportion of them can be observed among consumers in the Dominican Republic and in the UK, while the most significant proportion is among Spanish respondents (42%) (Gomez-Luciano et al. 2019) (Table 2). It is to note that 70% and 67% of consumers in China and in the UK would be willing to reduce their meat consumption, respectively, while only 38% in Australia. The willingness to accept (WTA) lab-grown cells was consistent with this; the respondents in the UK and China showed

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a significantly higher WTA of lab-grown cells than in Australia (Ford et al. 2023) (Table 2). In the USA, China and India, 24%, 7% and 11% of respondents would not buy lab-grown cells, respectively. The slightly and moderately likely buyers were 47%, 34% and 33%, respectively. In contrast, the proportion of very and highly likely respondents was nearly double that in China and India compared to the USA (Bryant et al. 2019b). There was also a significant difference in the WTB score (Table 2). In Singapore, the perception of unnaturalness and food neophobia emerged as the most substantial barrier to consuming lab-grown cells. At the same time, the positive attitudinal factors such as drug residue concerns, zoonotic diseases and animal welfare were not effective on WTE.

However, as seen in Table 2, respondents in each study received different information about lab-grown cells, which could have influenced their decision. Perceptions of meat substitutes, such as lab-grown cells, vary across countries due to different traditions, meat-eating habits, religions and several other reasons. Despite all this, some conclusions can be made. In countries with high meat consumption, like in the USA and Australia, meat remains the preferred choice, as it symbolises national pride and masculinity. Similarly, in France, people have strong adherence to culinary traditions. At the same time, in many Asian or South American countries, where rising living standards are driving a significant increase in meat consumption, openness towards lab-grown cells has grown.

Impact of only technological information on the willingness to accept, try, buy, eat, and pay a premium price for lab-grown cells

The acceptance of lab-grown cells is significantly influenced by whether people know it and what information they have received about it.

In the study by Siegrist et al. (2018), the only difference in Tech info was that the concept of "biotechnology" or "tissue cultivation" was included during the production of lab-grown cells. People seem to be so averse to biotechnology that a 9% and 8% difference in WTB and WTE emerged in favour of the "tissue cultivation" group (Table 3). Chinese respondents who were already familiar with lab-grown cells had 13%, 10% and 10% higher WTA, WTT and WTB, respectively, compared to those who had no prior knowledge of them (Min et al. 2024). An even greater difference (29%, 23% and 20% difference in WTA, WTT and WTB, respectively) was registered among respondents who did not receive any specific information about lab-grown cells than those who received positive information about them (Table 3).

Tech info usually has a negative effect on the acceptance of lab-grown cells, as people are generally averse to food production using technological methods, which can even lead to food disgust. Based on the data summarised in Table 3, observing any apparent changes or trends would be difficult. It was also observed in the tables before that the acceptance of lab-grown cells decreased from WTA to WTP, and people accepted them more quickly than they actually ate them. This change, for example, in the study of Dupont and Fiebelkorn (2020) and Weinrich et al. (2020) is much more pronounced than in the paper of Dupont et al. (2022). Much lower WTT and WTE were observed in the USA (Wilks and Phillips 2017) than in Germany (Weinrich et al. 2020; Dupont et al. 2022), which shows that it can be detected not only under the same conditions (Table 2) but also in different studies.

In conclusion, the role of information is significant. However, random, difficult-to-explain differences emerged across studies conducted within the same country, even when similar or identical information was provided. Nonetheless, the findings consistently reflected cross-country differences in consumer behaviour, already justified in Chapter Willingness to accept, buy, try, and eat lab-grown cells across different countries.

Impact of technological and additional information on the willingness to try, buy, and pay a premium price for lab-grown cells

"The same as meat" often appears in addition to Tech info during studies. This makes it clear that they want to reduce the negative impact of Tech info because if lab-grown cells are the same as meat, it is much more acceptable to consumers. In addition, as Add info, the environmental, nutritional, and health benefits of lab-grown cells are introduced to the respondents, which, individually and together, greatly help the acceptance of lab-grown cells.

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In the study of Rombach et al. (2022), in addition to Tech info, the respondents could only read that lab-grown cells are the same as meat. The low WTT, WTB and WTP scores in the average of the ten countries can be misleading, but it should be considered that this result was achieved using a Likert scale of 1–3 (Table 4). The investigation by Bryant and Sanctorum (2021) differed from the previous one because, in addition to the Tech info, it also included that it is identical to meat and does not require the killing of animals. As a novelty, in addition to the WTB, it was investigated how the WTP developed in the case of a 10%, 25%, 50% and 100% higher price. Prices by 10% and 25% higher, probably and certainly were 24% and 12%, respectively (Table 4). In an Italian study (Mancini and Antonioli 2019), in addition to Tech info, the participants received a wide range of Add info (Table 4). The ratio of WTT and WTB was high, and the WTP also developed accordingly.

It is possible to get to know the opinions of consumers better if, in addition to one group (Tech

Table 4. Willingness towards lab-grown cells (Tech and Add info)

Origin	Information	Unit	WTT	WTB	WTS	WTP	Authors
10 countries	Tech + Add info (identical to meat) 1–3 scale	mean	2.01	1.73	–	1.39	Rombach et al. (2022)
Belgium	Tech + Add info (identical to meat, animals are not killed)	mean %		3.13 39	–	–	Bryant and Sanctorum (2021)
Belgium	Tech + Add info WTP 10% more	% %	–	–	–	5^{1} 19^{2}	Bryant and Sanctorum (2021)
Belgium	Tech + Add info WTP 25% more	% %	–	–	–	2^{1} 10^{2}	Bryant and Sanctorum (2021)
Italy	Tech info + the same as meat, reduction of environmental footprint, land and water use, health and food safety benefits, omega-3	% % %	54^{1} 24^{2}	44^{1} 27^{2}	–	$14^{+10\%}$ $14^{+20\%}$ $6^{+30\%}$	Mancini and Antonioli (2019)
Italy	Tech + Add info (the same as meat)	% % %	77	66	–	$17^{10\%}$ $15^{20\%}$ $7^{30\%}$	Mancini and Antonioli (2020)
Italy	Tech + Add info (the same as meat, environmental, health and food safety benefits)	% % %	79	71	–	$19^{10\%}$ $19^{20\%}$ $9^{30\%}$	Mancini and Antonioli (2020)
Belgium	Tech + Add info (the same as meat)	% %	24^{1} 67^{2}	19^{1} 69^{2}	–	14^{1} 44^{2}	Verbeke et al. (2015b)
Belgium	Tech + Add info (the same as meat, environmental, health, nutritional benefits – omega-3)	% %	42^{1} 51^{9}	36^{1} 58^{2}	–	36^{1} 28^{2}	Verbeke et al. (2015b)
USA	Nutritionally equivalent: Tech + Add info (the same as meat)	mean		3.29	–	–	Baumann and Bryant (2019)
USA	Nutritionally enhanced: Tech + Add info (saturated fat replaced with omega-3 oils, vitamins and minerals added)	mean		3.28	–	–	Baumann and Bryant (2019)
USA	Together	% %	25^{1} 37^{2}	11^{1} 25^{2}	14^{1} 33^{2}	5^{1} 18^{2}	Baumann and Bryant (2019)

[1]Certainly; [2]Probably; [10%, 20%, 30%]Higher price

WTB = willingness to buy; WTP = willingness to pay a premium price; WTS = willingness to substitute lab-grown cells for meat; WTT = willingness to try

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Table 5. Willingness towards lab-grown cells (Tech and more Add info)

Origin	Information	Unit	WTT	WTB	WTE	WTS	WTP	Authors
USA	Basic + meat is unnatural (use of antibiotics and hormones, risk of diseases, meat contains additives)	mean	3.98	3.57	–	3.65	–	Bryant et al. (2019)
USA	Basic + control (many benefits for human health, animals, and the environment, delicious meat)	mean	3.91	3.49	–	3.57	–	Bryant et al. (2019)
USA	Basic + challenging the appeal to nature (many benefits for human health, animals, and the environment)	mean	3.81	3.38	–	3.45	–	Bryant et al. (2019)
USA	Basic + lab-grown cells are natural (the process of cell growth is present in all natural life)	mean	3.81	3.45	–	3.48	–	Bryant et al. (2019)
Italy	Control: Tech + Add info (its taste and price are the same as meat)	mean	4.2	3.5	–	2.9	–	Piochi et al. (2022)
Italy	Control + human safety (pathogen- and zoonosis-free, antibiotic-free)	mean	4.4	3.8–3.9	–	3.4	–	Piochi et al. (2022)
Italy	Control + animal welfare (no animal breeding, no animal slaughtering)	mean	4.3–4.4	3.8	–	3.5	–	Piochi et al. (2022)
Italy	Control + environmental impact (99% land use reduction, 82–96% water consumption reduction)	mean	4.3	3.7	–	3.2–3.3	–	Piochi et al. (2022)
USA	Tech and Add info (the same as meat, better nutritional content) + the same as meat (like meat, and can be healthier to eat)	mean	3.85	–	3.48	3.49	–	Bryant and Dillard (2019)
USA	Tech and Add info (the same as meat, better nutritional content) + societal benefits (reducing harm to the environment and helping animals)	mean	3.79	–	3.50	3.37	–	Bryant and Dillard (2019)
USA	Tech and Add info (the same as meat, better nutritional content) + high tech (high technology in a laboratory)	mean	3.30	–	3.03	3.03	–	Bryant and Dillard (2019)
China	Basic: Tech + Add info (the same as meat)	%	70	58	–	34	16	Dempsey and Bryant (2020)
China	Basic info + health benefits (less fat, added vitamins, minerals, lower health risk)	mean	3.85	3.62	–	3.18	2.72	Dempsey and Bryant (2020)
China	Basic info + reliable supply (not affected by animal diseases, not dependent on the availability of farmland or water)	mean	3.82	3.65	–	3.12	2.55	Dempsey and Bryant (2020)
China	Basic info + save animal and the planet (lower environmental footprint; using less water and land, less greenhouse gas emissions, lower animal suffering)	mean	3.80	3.55	–	3.27	2.62	Dempsey and Bryant (2020)
China	Basic info + high tech (high technology in a laboratory)	mean	3.76	3.47	–	3.04	2.46	Dempsey and Bryant (2020)
Germany	Tech + Add info (the same as meat)	%	69	48	–	–	–	Baum et al. (2021)
Germany	Tech + Add info (positive-complex: much less greenhouse gas emissions, land, water and energy use, healthier and more nutritious, clear advantages for animal welfare) 1–6 scale	mean	–	4.74	–	–	–	Baum et al. (2021)

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Table 5 to be continued

Origin	Information	Unit	WTT	WTB	WTE	WTS	WTP	Authors
Germany	Tech + Add info (positive-simple: less energy and land, healthier, more nutritious, reduced animal suffering) 1–6 scale	mean	–	4.65	–	–	–	Baum et al. (2021)
Germany	Tech + Add info (negative-simple: increased greenhouse gas emissions, neither healthier nor more nutritious, nor better for animal welfare, not the same as meat) 1–6 scale	mean	–	3.70	–	–	–	Baum et al. (2021)
Germany	Tech + Add info (negative-complex: more carbon emissions, neither healthier nor safer, no benefit for the immune system, nothing like meat) 1–6 scale	mean	–	3.29	–	–	–	Baum et al. (2021)

WTB = willingness to buy; WTE = willingness to eat; WTP = willingness to pay a premium price; WTS = willingness to substitute lab-grown cells for meat; WTT = willingness to try

info + the same as meat), another group receives broader Add info. In the study of Verbeke et al. (2015b), the respondents showed a high percentage of WTT and WTB, especially after reading the Add info (Table 4), the rate of "surely" increased by 18% and by 17%, respectively. The ratio of real WTP also increased by 22%. In a similar study by Mancini and Antonioli (2020), the ratio of WTT and WTB barely increased in the case of Add info. However, it should be noted that even with Tech info, the respondents achieved results of 77% and 66%, respectively (Table 4). On the other hand, in Baumann and Bryant's (2019) study, WTB did not change due to Add info (Table 4).

Based on the results, it can be concluded that a high willingness ratio was already achieved in the case of Tech info + the same as meat. As a result of the Add info, the acceptance of lab-grown cells, especially in the Certainly category, increased significantly. It is clear that with the given information, consumers' acceptance of lab-grown cells can be improved.

Willingness to buy, try, eat, and pay a premium price for lab-grown cells based on extra information and framing

Consumers learn the most about the influence of information on the acceptance of lab-grown cells when there is more Add info in addition to the Tech info. Examining the effect of positive and negative information is particularly interesting.

Bryant et al. (2019b) divided the US adults into several groups (Table 5). The "Meat is unnatural" group received the lowest WTT and WTB scores. The Control group, which listed many benefits, received the second highest score. The two groups that emphasised naturalness received similar scores.

At the same time, it should be noted that the information that lab-grown cells dishes are made by a natural process similar to the fermentation of yoghurt and beer misleads the respondents.

Bryant and Dillard (2019) and Dempsey and Bryant (2020) provided similar information (Table 5) and asked participants' opinions. In both cases, the group that received the information "Heath benefits" or "Heathier to eat" scored the highest. "Societal benefits" and "Save animals and the planet" received fewer points as social information does not directly affect the individual. "High tech" information resulted in the lowest score, spectacularly in Bryant and Dillard's (2019) study and slightly in Dempsey and Bryant's (2020) study.

The study of Baum et al. (2021) is an example of how much the respondents' opinions changed when positive or negative information was given on the same topic (environment, animal welfare, healthiness, etc.), a difference of more than 1 point emerged in the WTB between positive and negative groups (Table 5).

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Positive information highlighting health benefits increases respondents' willingness to accept lab-grown cells. In contrast, Tech information tends to negatively affect respondents' opinions. Overall, it is evident that both positive and negative information significantly impacts the acceptance of lab-grown cells.

CONCLUSIONS

Consumer acceptance of lab-grown cells is still emerging, and many consumers worldwide still have a reduced awareness of lab-grown cells. Food neophobia is a real barrier. Generally, consumers find lab-grown cells "unnatural", which is linked to lower willingness to try them. In addition, cultures with strong culinary traditional links may be opposed to the concept. Improving the basic knowledge is the first important step. Early knowledge transfer can prevent misconceptions from taking root. If consumers become more familiar with this product, they will be more open-minded. Consumer acceptance of lab-grown cells is more strongly influenced by perceived disadvantages than by potential benefits. However, exposure to positive and accurate information has been shown to increase willingness to accept, try, buy, eat, sell, and pay more for such products. In several studies reviewed, misleading information was provided to respondents. It is essential that consumers will receive accurate and evidence-based information, as their perception and acceptance of lab-grown cells are significantly influenced by the information received. Besides, companies dealing with lab-grown cells must prioritise replicating the sensory experience of meat while focusing on food safety and cost reduction. Effective, appropriate and transparent communication can significantly improve the consumer acceptance of lab-grown cells. Positive framing – highlighting personal and social benefits – improves acceptance, while negative framing can trigger resistance.

While challenges and unanswered questions exist, the review provides insight into how information can effectively influence the consumer acceptance of lab-grown cells.

Conflict of interest

The author declares no conflict of interest.

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