sustainability

MDPI

Review

Sustainability of Alternatives to Animal Protein Sources, a Comprehensive Review

Marian Gil [1], Mariusz Rudy [1,*], Paulina Duma-Kocan [1], Renata Stanisławczyk [1], Anna Krajewska [2], Dariusz Dziki [2] and Waleed H. Hassoon [3]

[1] Department of Agricultural Processing and Commodity Science, Institute of Food and Nutrition Technology, College of Natural Sciences, University of Rzeszow, Zelwerowicza 4, 35-601 Rzeszów, Poland; mgil@ur.edu.pl (M.G.); pduma@ur.edu.pl (P.D.-K.); rstanislawczyk@ur.edu.pl (R.S.)
[2] Department of Thermal Technology and Food Process Engineering, University of Life Sciences in Lublin, 31 Głęboka Street, 20-612 Lublin, Poland; anna.krajewska@up.lublin.pl (A.K.); dariusz.dziki@up.lublin.pl (D.D.)
[3] Department of Animal Production, College of Agriculture, Al-Qasim Green University, Babylon 51001, Iraq; waleedhassoon@agre.uoqasim.edu.iq
* Correspondence: mrudy@ur.edu.pl; Tel.: +48-0-17-785-52-60

Abstract: The manuscript was prepared to conduct a thorough analysis and deepen the understanding of sustainable food production and diets within the context of the challenges posed by intensive agricultural practices and their environmental impacts, as well as their effects on human health. The rapid growth of the human population necessitates an increase in food production to meet nutritional needs. However, increasing the production of animal-derived products, which are significant protein sources, is likely to worsen undesirable consequences, such as global climate change, greenhouse gas emissions, and a larger carbon footprint. Traditional farming techniques also contribute to environmental contamination due to the use of synthetic fertilizers and pesticides. Transitioning to a sustainable food production model that addresses food needs while protecting consumer health and the environment is crucial. The challenge for the food industry and research centers is to find and develop the production of alternative sources of protein. In addition to the technological problems that must be solved, there is consumer education focused on healthy eating and overcoming psychological barriers related to the consumption of new foods.

Keywords: sustainable food production; sustainable diet; alternative protein sources

Citation: Gil, M.; Rudy, M.; Duma-Kocan, P.; Stanisławczyk, R.; Krajewska, A.; Dziki, D.; Hassoon, W.H. Sustainability of Alternatives to Animal Protein Sources, a Comprehensive Review. *Sustainability* **2024**, *16*, 7701. https://doi.org/10.3390/su16177701

Academic Editors: Aspasia Vlachvei and Anastasios Panopoulos

Received: 15 July 2024
Revised: 2 September 2024
Accepted: 3 September 2024
Published: 4 September 2024

1. Introduction

The global human population is experiencing rapid growth, with projections indicating an increase to approximately 10 billion by 2050. Ensuring sufficient, secure, and sustainable food provision for this growing population poses a significant challenge, especially considering resource depletion, pandemics, and climate change. Over the past five decades, both meat production and consumption have increased, with expectations that this trend will continue to meet the rising demand for animal protein [1–3].

According to the World Economic Forum, global meat consumption is expected to double by 2050, driven by population growth and rising incomes, which will lead to changing dietary preferences. Despite the increasing recognition of plant-based diets and the popularity of vegetarianism, high levels of animal-origin food consumption persist in developed countries [4]. The rise in meat consumption will exacerbate adverse effects such as global climate change, greenhouse gas emissions (GHGs), and an increased carbon footprint. Additionally, traditional meat production contributes to water pollution due to the heavy use of fertilizers and pesticides [5,6].

The alarming forecast of greenhouse gas emissions growth is particularly concerning, as a significant portion of the 7.1 gigatons of carbon dioxide emissions, constituting approximately 14.5% of total emissions [7], originates from livestock supply chains [8]. Livestock farming for meat and dairy products accounts for 65% of total greenhouse gas emissions, with 45% of these emissions being methane [9].

The causes of food insecurity are multifaceted and include persistent inequalities, systemic weaknesses in food systems, and disruptive events such as the war in Ukraine, which has significantly impacted global food prices. Climate change poses a serious threat to food systems, as extreme weather events, including floods, droughts, and wildfires, increase the pressure on these systems and severely reduce crop yields [10].

Agriculture plays a significant role in surpassing three planetary boundaries: biodiversity loss and the biogeochemical cycles of nitrogen and phosphorus. Although current global food production yields a net surplus of over 80% of protein and approximately 8% calories, more than 800 million people experience food shortages, and over 2 billion suffer from malnutrition, which includes deficiencies in protein, vitamins, and minerals, as well as obesity. The environmental impact of food production is unsustainable [11].

Numerous countries have established ambitious targets to eradicate hunger by 2030 in alignment with the UN Sustainable Development Goal 2. However, the 2023 Global Report on Food Crises [12] reveals that in 2022, around 258 million people in 58 countries and territories experienced severe food insecurity. Given these climate challenges and existing inequalities, the development of sustainable and resilient food systems is more essential than ever [13]. An essential element of these systems is sustainable diets, defined as "those diets with low environmental impact that contribute to food and nutrition security and to the healthy life of present and future generations. A sustainable diet protects and respects biodiversity and ecosystems, is culturally acceptable, accessible, economically equitable and affordable; nutritionally adequate, safe and healthy, while optimizing natural and human resources" [14]. Defining diversified diets in this way shows the areas of impact in terms of: (1) well-being and health; (2) biodiversity, environment, and climate; (3) justice and fair trade; (4) organic, local, and seasonal food; (5) cultural skills and cultural heritage; and (6) food and nutrient requirements, food security, and availability [15]. The causes of food insecurity are multifaceted, involving persistent inequalities, systemic vulnerabilities within food systems, and disruptive events such as the war in Ukraine, which has significantly influenced global food prices. Climate change presents a significant threat to food systems, with extreme weather events, including floods, droughts, and wildfires, intensifying stress on these systems and severely reducing yields [10].

The aim of this study is to conduct an analysis and update the knowledge regarding sustainable food production and diets in the context of threats posed by intensive production systems, their environmental impact, and implications for human health. This research includes a review of consumer dietary behaviors from various countries concerning environmental threats and provides a synthetic overview of the advantages, development potential, and barriers to the production of alternative protein sources.

2. Methodology

This study involved an analysis of scientific publications focused on sustainable food production, sustainable dietary patterns, and alternative protein sources. The authors assessed the impact of traditional production methods on the natural environment and the influence of traditional dietary patterns on health. Against this backdrop, the study reviewed potential opportunities and challenges associated with the production of alternative protein sources as measures towards environmental protection, sustainable diets, and supporting sustainable development.

The multi-criteria evaluation method was used in the literature review. This study utilized the research question of what arguments support sustainable development in food production and the implementation of sustainable diets to meet food needs and improve health. The literature search within the analyzed scope was conducted between November 2023 and August 2024 using the Web of Science and Scopus databases. Scopus, one of the major commercial bibliographic databases, encompasses scientific literature from nearly every discipline, with a record count exceeding 94 million [16]. Web of Science provides access to a full spectrum of biomedical literature from agriculture to public health and zoology, drawing from multiple databases focused on multidisciplinary content in the natural sciences. Through specialized collections, the Web of Science enables searches for content relevant to scientists from various fields, including physics, engineering, and food science [17].

To obtain a broad spectrum of search results, combinations of keywords were applied: sustainable development, food production, sustainable diet, and alternative protein sources. For increased search precision, combinations of these words were employed. To depict consumer behaviors regarding the challenges of sustainable development, studies from various geographic regions and cultural backgrounds were selected. The search results were verified by researchers for relevance to the topic and purpose of the study. Subsequently, 284 articles that were most relevant to the topic and purpose of the study were subjected to further analysis.

Articles for review were included based on the following criteria: studies involving consumers engaging in activities related to sustainable development or sustainable diets and publications related to research on the development, implementation, and improvement of technologies for alternative protein sources production. In the case of review articles, synthetic coverage of the subject matter concerning current achievements in the development of alternative protein source production methods, comprehensive presentation of the effects of intensive food production, and prospects for transitioning towards sustainable food production and nutrition were considered.

3. Sustainable Development in Food Production

Food security and environmental sustainability are essential for the progress and development of economies and societies worldwide. Food security encompasses sufficient access for communities to safe, culturally acceptable, nutritionally appropriate, and wholesome food that maximizes social confidence and equity through a sustainable food system [18]. Food and agricultural security means access to safe and nutritious food and sustainable development. Sustainability is an integral component and prerequisite for food security, and nutrition is a prerequisite for availability, stability of supply, access, and utilization [16]. Today, food security and the impacts of industrial agriculture and humans on climate and ecosystems are becoming increasingly complex [17,19], and food insecurity is increasing. Existing agricultural systems are failing to address the global health and nutrition challenge, causing and exacerbating environmental damage and social injustice [20].

In the second half of the 20th century, global food production and distribution increased rapidly as a result of the intensification of agricultural practices. This was due to advances in crop research, expansion of agricultural land, mechanization, and the widespread use of synthetic fertilizers, pesticides, and genetically modified high-yielding crop varieties [21,22]. The significant increase in production, due to population growth and high global meat consumption, has raised concerns from the perspective of environmental protection, public health, ethics, and ideology. Scientists have identified several environmental problems, such as poor management of water resources and arable land, emissions of harmful gases, and loss of biodiversity [23].

Currently, there is substantial evidence suggesting that our existing global food systems and consumption patterns are unsustainable for both human health and the planet [24]. Food production contributes to approximately 21–37% of global greenhouse gas emissions [25], with agriculture responsible for about 70% of the world's freshwater usage [26,27]. The environmental impact of diet is due to the amount of water and soil used, the amount of fertilizer and energy required for production, which are related to the use of potentially harmful substances (such as pesticides and medicines) and the reduction of biodiversity as an indicator of environmental damage, indicating the "environmental cost" of a food or food group [28]. The largest water footprint is from beef production in the pasture model, followed by plant-based scenarios, at around 57 and 42 m^3, respectively [29]. Smaller water footprints are observed for animals kept in confinement, such as beef, pork, and chicken (~3.76–17.05 m^3). This oscillation between animal proteins, even taking into account the on-farm and processing stages, is related to environmental factors (for example, ambient temperature and humidity), drinking water temperature, water quality, feed composition (nature of food and dry matter content), feed intake, animal size, body weight gain rate, and composition [30]. The reduction in environmental impact was progressively greater from a flexitarian diet to a vegan diet for all factors except the water footprint, which had the opposite trend. Reduction values ranged between 54–87%, 2–11%, 8–11%, and 41–46% for GHG emissions, freshwater use, cropland use, and fertilizer use (summing N footprint and P footprint), respectively [31,32]. When assessing energy requirements, it is estimated that about 89% of the total impact of plant products is attributed to the cultivation stage and only 10% to the grain processing stage. In comparison, the impact related to animal protein, more specifically beef, depends on the animal production method, and the environmental burdens associated with this stage range from 24% to 50%, while the slaughter and processing stage of meat can represent values greater than 74% of the total process impact [33]. The Mediterranean diet, as well as some diets related to national dietary guidelines in the study by Fresán and Sabaté (2019) contributed to significantly lower GHG emission reductions than vegetarian patterns (10% compared to a range of 22–87%) [34].

The use of antibiotics and other drugs in animal husbandry and agriculture also has negative implications. Public health concerns are particularly troubling due to the link between the consumption of red and processed meats and diseases such as colorectal cancer [35] and cardiovascular issues [36,37].

A large body of scientific evidence underscores the urgent need to change current dietary patterns in order to mitigate climate change. As a result, many initiatives and policies have been implemented to promote sustainable development. These efforts include international actions, such as the introduction of the UN Sustainable Development Goals [38] and national actions, such as the implementation of official dietary guidelines in several EU countries that explicitly recommend more sustainable diets [39].

The growing recognition of the necessity for a more sustainable food production system is evident. This system must satisfy food demands while protecting consumer health and the environment. Achieving this shift requires cooperation between the food industry, government regulatory agencies, and the scientific community to develop and implement strategies for preventing chemical contamination in food. Progress in food technology, risk assessment, and regulatory frameworks presents promising opportunities to ensure both food safety and sustainability [40].

Sustainable development has been integrated into international agreements, national regulations, and policies. Nearly all agri-food production necessitates some degree of land use. Decisions regarding land use impact where and how food systems operate, and subsequently, food systems affect land, water, and climate [41].

One of the sustainable agricultural practices is crop rotation. It is one of the basic agricultural methods, which has been replaced by intensive farming. It is crucial for optimizing the use of both artificial and natural resources. Crop rotation maximizes the efficiency of resource use and mitigates environmental complications that often result from continuous cropping [42,43]. Another practice is the use of polyculture, which is the simultaneous cultivation of many plant species in the same space, which increases land use efficiency and potentially farmers' income [44]. Polyculture can be practiced in aquaculture, where it involves the joint cultivation of different species in the same aquatic environment, improving production profitability [42,45]. Another principle of sustainable agriculture is integrated pest management. It uses different pest control methods. These methods include biological control, habitat manipulation, and pest-resistant crop varieties. The aim of integrated pest management is to destroy pests while effectively minimizing harmful effects on the environment. Integrated plant protection reduces the dependence on chemical pesticides, contributing to maintaining ecological balance and preserving biodiversity [42]. An integral part of sustainable agriculture is also the use of renewable resources such as water and energy, which is crucial to minimizing the environmental footprint of agricultural activities.

Sustainable agriculture also uses technological achievements (in the framework of precision agriculture) and biotechnology. Precision agriculture uses advanced technologies to precisely adjust the use of inputs, such as fertilizers and pesticides, taking into account the variability of field conditions. The use of precision agriculture technologies takes place at important stages of the crop growth cycle (soil preparation, sowing, crop management, and harvesting), but also in animal breeding [46]. It has the potential to improve environmental practices by reducing unnecessary use of inputs and reducing pollution in sustainable agriculture. In addition, advances in digital technology, including 3D visualization [47,48] are crucial to engage younger generations and promote sustainable farming practices [49]. Two major technological trends can be distinguished in precision agriculture: (1) big data and advanced analytical capabilities, (2) aerial imagery, feeding and milking robots, and smart sensors [50].

The development of precision agriculture has been a major driver for the transformation of biotechnology, which offers a wide range of benefits, from increased crop resilience to reduced chemical inputs. It has thus had a significant impact on the environment and the economy [51,52].

The implementation of new production systems, increasing innovation in zootechnical practices are able to provide improved feed efficiency and cattle growth rates, resulting in a better impact on meat quality and carcass characteristics, in addition to reducing carbon footprint, ammonia emissions, and meat production costs [53]. Biotechnology centers are increasingly involved in maintaining the competitiveness of the poultry system in the face of emerging challenges. Moreover, the global experience of producers in the field of poultry breeding, as well as beef and pork production systems, shows that the formation of the quality of meat products begins with cultivation and is controlled at all stages of the food chain [54].

It is important to recognize that sustainable development has been a key focus of the United Nations (UN) for more than 30 years. These principles were initially presented in the 1987 Brundtland Report and were further detailed at the 1992 "Earth Summit" in Rio de Janeiro, where Agenda 21 was established [55]. A decade later, the 2002 "World Summit on Sustainable Development" in Johannesburg outlined strategies for more effective implementation of Agenda 21. Consequently, sustainable agriculture has progressively emerged as a major global objective [15]. Policies such as the United Nations Sustainable Development Goals [56] and the European Green Deal [57] are pivotal for global decision-making aimed at mitigating the anthropogenic climate crisis. Although these policies have different objectives, they share a commitment to promoting sustainable agri-food systems and environmental protection [58].

Additionally, several important initiatives related to sustainable development goals exist at both international and European levels. Internationally, the 2015 Paris Agreement on climate change, established during the climate conference in Paris, France, demonstrates strong links to the 2030 Agenda. On the European level, the European Green Deal, adopted by EU member states in 2019 [59], supports initiatives aimed at eradicating hunger, achieving food security, improving nutrition, and promoting sustainable agriculture, particularly within the framework of the "Farm to Fork" strategy [60].

Sustainable development in the agri-food industry pertains to meeting present and future food needs while preserving the integrity of natural resources and ecosystems [61]. This includes reducing the carbon footprint, safeguarding water and soil quality, and conserving biodiversity [62]. However, it should be viewed from a broader perspective that encompasses people, planet, and industry [63,64]. Sustainable food production, conceptualized as a guiding principle within the food cultivation system, intersects with various critical systems such as energy, trade, and healthcare, and has garnered escalating attention since the previous century [65]. At its core, it is grounded in principles that emphasize heightened awareness and empowerment, ensuring that short-term profitability is harmonized with long-term stability [66].

Increasing global incomes and evolving consumer preferences have heightened the demand for protein. Animal protein currently plays a crucial role in meeting this demand, and its production is projected to rise in the coming years [67,68]. However, constraints such as limited agricultural land and labor have hindered the expansion of animal husbandry, reaching saturation points in recent times. Food producers face obligations to uphold animal welfare and preserve land and biodiversity [69], posing challenges to efforts aimed at rapidly increasing meat production and supply in the short term [70].

4. Sustainable Diet and Consumption Patterns

The Lancet Commission in 2019 highlighted the pivotal role of food in sustainable development: "Food is the single strongest lever to optimize human health and environmental sustainability on Earth. However, food currently threatens both people and the planet" [15,24]. Sustainable food production encompasses diverse viewpoints and tackles concerns spanning the environment, economy, and society. Developing sustainable food production systems encounters obstacles such as environmental decline, competition for resources, rising food needs, and the incorporation of agriculture into the global economy [22]. Socially, sustainable food production aims to secure food and nutrition for future generations by integrating local resources and supply chains [71].

Transformative change across the entire food system, from farm to waste, is essential, yet agriculture alone is unlikely to achieve global climate goals without significant shifts in dietary patterns on the consumer side [72]. A globally advocated approach is the transition to a "sustainable diet," which emphasizes high consumption of plant-based foods and whole proteins while reducing animal-based food intake. This shift promises additional benefits for both human health and environmental sustainability [24,73,74].

Adopting a less processed diet can benefit both health and environmental sustainability. Ultra-processed foods, which are unnecessary for a balanced diet, contribute to excessive consumption, one of the main drivers of the growing negative environmental impact [75,76].

The production of ultra-processed food is also a significant contributor to environmental pressure [75–79]. Each stage of the life cycle assessment of ultra-processed food production—monoculture farming, energy-intensive processing, long transportation chains, and excessive packaging—contributes to environmental pressure [76,80]. To align the food sector's impact on climate with sustainable development goals and commitments to greenhouse gas emissions under the Paris Agreement, a shift in current consumption patterns is necessary [24,81,82]. Voluntary adjustments by consumers towards sustainable development will also be crucial in reducing the carbon footprint. Understanding changes in behaviors, habits, or strategies that consumers may adopt to reduce their greenhouse gas emissions is essential [81]. Adopting a less processed diet can benefit both health and environmental sustainability. Ultra-processed foods, unnecessary in a balanced diet, contribute to overconsumption, which is one of the main causes of the growing negative impact on the environment [75,76].

A sustainable diet protects and respects biodiversity and ecosystems and is culturally acceptable, accessible, economically fair, and affordable. This definition is widely accepted by the scientific community and typically appears in most works published on the subject of sustainable diet [15,83]. Sustainable consumption is often identified with ecological consumption. In line with this trend, the key to achieving the goal of sustainable development is changes in the area of consumption, not necessarily related to limiting consumption, but modifying it to minimize negative external effects. The concept of sustainable consumption is often considered in a narrow sense, focusing on ecological aspects while marginalizing the other two aspects of sustainable development to which it refers, namely economic and social [84].

Consumer attitudes towards sustainable diets are presented in Table 1.

Table 1. Selected consumer attitudes towards sustainable development.

Consumer Behaviors towards Sustainable Development	Source
– Two-thirds of respondents consider the ideals of sustainable development to a "moderate" or "high" extent during food purchases. – 95% of survey participants have altered or are interested to alter their behavior in response to climate, environmental, or sustainable development concerns, with 40% showing a strong inclination toward behavior change. – 95% of respondents have changed or are willing to change their behavior due to climate, environmental, or sustainable development concerns, with 40% strongly inclined to change their behavior. – Respondents reported increased consumption of organic products, seasonal eating, and purchasing locally produced food.	[81]
– Around 70% of consumers are open to buying products with reduced or more environmentally friendly packaged materials, and 45% are open to increasing consumption of reginal food by 30%. – 40% of consumers intend to increase consumption of organic food by 30%.	[85]
– Consumers find the following adjustments easiest to incorporate into their daily lives regarding sustainable development: increasing consumption of fruits and vegetables, reducing the use of plastic bags, opting for seasonal products, purchasing local food, and minimizing food by-products.	[86]
– In particular, Italian shoppers who prioritize ecological consumption show greater concern for sustainable development in their dietary choices and tend to adopt more sustainable lifestyles overall.	[87]
– Increased consumption of organically grown food correlates with greater intake of plant-based foods, reduced meat consumption, and overall improved nutritional quality.	[88]
– More than half of Belgian consumers indicated that they purchase locally or organically produced food to safeguard the environment.	[89]
– The most commonly practiced principles are buying locally produced products, purchasing organic products, and choosing smaller packaging. When it comes to protein-rich and dairy products, the second most frequently observed practice is purchasing minimally processed food.	[90]
– Choosing fresh, local, and seasonal food reduces transportation and storage (e.g., in refrigerators), resulting in reduced calories consumption.	[91]
– Consumption of organic food; 54% of respondents in a study conducted in the UK try to avoid and minimize food waste.	[92]
– British respondents tend to favor making minor adjustments to their behavior rather than adopting more substantial lifestyle changes related to diet and transportation.	[93]
– More than 60% of British adults are prepared to decrease their meat consumption.	[94]
– Consumers interested in reducing consumption of meat were also more open to consuming cultured meat.	[95]

When it comes to dietary behaviors associated with meat consumption, studies by Palomo-Velez et al. [96], Einhorn [97], and Moreira et al. [98] have highlighted certain issues related to environmental degradation, health problems, and endangered animal welfare [96–98]. These issues have become a major research focus in food sciences. The literature indicates a growing concern for understanding the current state of research and future directions for adopting food alternatives to reduce meat consumption and address significant challenges in health and sustainable development [97,99]. On the other hand, considering the central role of meat in dietary routines and its various hedonistic, social, and cultural aspects, many consumers may be reluctant to eliminate this component from their meals [100].

Promoting a global reduction in meat consumption is both necessary and urgent, though challenging [101]. However, meat consumption is a voluntary behavior that can be modified. Some consumers, known as flexitarians, have transitioned to more sustainable dietary patterns by reducing the frequency of meat consumption rather than completely eliminating it [102]. While total elimination of meat may seem unrealistic, intermediate behaviors like flexitarianism have gained popularity [103]. According to Minotti et al. [104], adopting a balanced and healthy diet had a 47% lower carbon footprint and a 25% lower water footprint than an unhealthy diet, while at the same time affecting income and monthly food expenditure by an average of 13% less. Additionally, such a diet had a 21% lower impact on sanitary costs related to cardiovascular diseases [104]. Providing information, particularly about environmental benefits, is crucial for encouraging positive opinions. Lack of knowledge about new technologies can lead to distrust and concerns about potential long-term negative consequences [105,106]. Both GMOs and cultured meat are perceived as technological innovations that evoke feelings of distrust and unease [106]. Limiting false equivalences, such as associating cultured meat with GMOs, is important [105]. Economic accessibility and spending patterns also influence how sustainable practices are adopted and valued in each country, from more practical and affordable approaches to a preference for higher-end products. Economically developed countries may have a higher percentage of consumers willing to consume sustainable food products or services due to increased income. Spaniards attach greater importance to the use of reusable bags, Colombians prefer to buy local products. They negatively assess the impact of meat consumption on sustainability and express the belief that vegetarian diets are more sustainable, and affordable prices ensured by intensive food production. Turkish consumers perceived the importance of socio-economic, environmental sustainability [107].

New technologies and products, along with changes in dietary patterns, such as the growing vegan population, have the potential to reduce the environmental impact of food production [108,109]. This change has stimulated the evolution of agricultural policy and investments in research and development from various governmental and private sectors. Emerging technologies and products, coupled with shifts in dietary habits like the increasing vegan population, hold promise for diminishing the environmental footprint of food production [108,109]. This shift has spurred advancements in agricultural policy and investments in research and development across governmental and private sectors. Due to the diversity in geographical and cultural diets and agricultural methods, strategies for dietary modification will differ across national and local contexts [110]. Research indicates that substituting animal-derived products with plant-based alternatives in affluent and middle-income households can substantially lower environmental impact [111–113] and reduce the prevalence and mortality rates of noncommunicable diseases [32,114,115]. A very important direction will be the use of plant protein due to its lower ecological footprint and additionally the search for other alternative protein sources, such as insect-based diets, microalgae proteins, or fungi, which will enable safer and less polluting protein production [104]. Harmonizing the consumption of alternative plant proteins with the aim of reducing the environmental impact does not seem to be sufficient for those who usually eat animal protein. This is because although agriculture has promising carbon sequestration rates (~56% of CO_2), it is estimated that 9.9% of global greenhouse gas emissions are still related to agricultural activities. In addition, another aggravating factor is deforestation, with agriculture being responsible for over 75% of the devastation of the world's territory [116].

Food waste is a substantial contributor to climate change, given that the environmental impact of producing each kilogram of unconsumed food equals that of a kilogram of consumed food. Similarly, food waste from plant-based diets generally has a smaller environmental footprint compared to waste from diets high in animal products [117]. In developed nations, household waste represents more than 40% of total food waste occurring at the retail or household level [118]. Per capita food waste at the household level remains a considerable concern across both high- and low-income countries. In 2019, households globally were responsible for 61% of total food waste, amounting to 931 million tons. Factors contributing to household food waste include excessive purchasing, over-preparation, large portion sizes, confusion over labels and expiration dates, storage challenges, and inadequate packaging, particularly for perishable items [119,120].

The environmental burden from food waste varies by country, depending on the quantity and type of waste and the stage at which it occurs. Research conducted across 15 countries found that food waste in affluent nations (such as the USA, Saudi Arabia, UAE, and Canada) had the most substantial environmental impact across nearly all categories assessed. In the USA, for instance, food waste contributed 172 million metric tons of CO_2 equivalent to climate change, depleted 22 million tons of fossil resources, and used 121 billion cubic meters of water resources. These environmental costs were markedly higher compared to those observed in lower-income countries such as South Africa, Mexico, Argentina, and Lebanon [121].

More effective public health initiatives are needed that promote healthy eating habits and overall lifestyles. To address this problem, school-based nutrition education programs are effective in promoting appropriate growth and improving children's physical, social, and mental health while laying the foundation for healthy habits throughout adulthood. According to the WHO guide, educational programs should be child-centered, promoting active participation, with a planned curriculum that is appropriately designed for different stages of development [122]. Successful in-school initiatives, some of which include digital components, have been implemented in many countries [123–127]. Approaches to promote sustainable diets encompass adopting vegan or vegetarian lifestyles, minimizing food waste, choosing seasonal foods, opting for organic products, and selecting meats with reduced carbon footprints [128]. Changing dietary habits can be challenging, especially when influenced by factors such as tradition or the desire for self-improvement [129]. Sustainable eating behaviors often involve reducing meat consumption, particularly red meat, although this is less frequently mentioned than other behaviors like eating locally or seasonally and reducing food waste. Dietary changes are not explicitly associated with a specific diet type (vegetarian, vegan, or plant-based) [4]. A nationwide survey in the UK found that meat reduction was not listed as the most important action for a sustainable lifestyle [130]. Sensory appeal is a significant factor in food choices, proving to be a key determinant of regular consumption [131]. Positive and negative sensory experiences did not deter participants from trying various plant-based meat substitutes (PBM), such as minced meat, burgers, sausages, and nuggets [132]. Vitale et al. estimate that the mere reduction of red and processed meat consumption in the traditional Italian diet would reduce CO_2 production per capita by as much as 31% and contribute to greenhouse gas emission savings of over 50%. However, considering that a drastic reduction in red and processed meat consumption is unrealistic in the short term, it is worth emphasizing that even less radical changes would be beneficial for the time being and should therefore be supported [133].

Consumer knowledge about sustainability plays a crucial role in food choices. Studies show that consumers are more likely to engage in eco-conscious purchasing when they understand the significance of sustainability attributes at the product level or have high subjective environmental knowledge. Conversely, they are unlikely to engage in sustainable behaviors if they lack sufficient information about the issue, its potential consequences, and how their actions can contribute to its resolution [134]. Even motivated and concerned consumers need specific knowledge to choose sustainable alternatives from available options [135].

Common challenges for consumers include the complexity of preparing and locating meat-free meal choices. Other barriers include the habitual nature of meat consumption and its perceived necessity for a "proper meal," as well as a lack of awareness about the negative health and environmental impacts of high meat consumption. Negative perceptions and concerns about the high sodium content and highly processed nature of substitute products also play a significant role [136–138].

5. Alternative Protein Sources

To adapt to the swift changes in the food supply chain and the consequent intense demand for high-protein products, the food production industry has been actively working to boost the production and processing of these products in recent years [139]. To address the 'diet-environment-health' trilemma [115] for both current and future generations, it is crucial to introduce sustainable and ethically justified alternatives to traditional meat production and consumption, such as plant-based protein sources [140] and insects [141]. Table 2 outlines the opportunities and challenges associated with alternative protein sources.

Table 2. Opportunities and challenges related to alternative protein sources.

Alternative Protein Sources	Advantages and Development Potential	Reference	Barriers and Risks	Reference
Plant-based alternative foods (PBAF)	– Products frequently emulate the function of seafood and meat in the diet, providing consumers with real opportunities to transition to a diet with reduced meat and seafood content.	[142–149]	– The extensive processing involved in certain plant-based products has hindered their acceptance and sparked discussions regarding their long ingredient lists, nutrient composition, and potential health effects.	[94]
	– They are consumed as part of numerous dietary patterns aimed at promoting health and managing diseases, including the Mediterranean-style diet, the nutritional strategies to reduce hypertension diet, low glycemic index diets, and fiber-rich diets.	[150–157]	– Consumers perceive plant-based products as excessively processed and potentially harmful to health.	[158,159]
	– They allow for achieving satisfactory levels of protein in the diet, with the total replacement of animal-derived protein by other sources of protein such as amaranth, quinoa wheat, legumes, and soy-based products (tofu and tempeh). Therefore, protein-rich plants, such as legumes, can help reduce the demand for animal protein sources, which would bring enormous benefits to the environment.	[149,160,161]	– The significant processing that some plant-based food alternatives (PBAF) undergo may classify them as UPF and leads to increased salt and sugar intake, the consumption of which is associated with various adverse health outcomes.	[162–164]
	– Consumption of plant-based alternative foods has experienced a significant increase and shows signs of increasing. Higher consumption rates are observed among individuals who consume less meat, supporting the hypothesis that these products facilitate the transition to a diet with reduced animal-derived product intake.	[165]	– These products are seen as more modern, artificial, and expensive in comparison to legumes, which are viewed as healthier and more environmentally friendly.	[166]
	– There is a pressing need to expand the availability of plant-origin meat substitutes (PBMS) to meet consumer demand. Sales of plant-based products in Europe saw a notable increase of 49% from 2018 to 2020, with Spain alone experiencing a 32% rise in PBMŚ volume of sales from 2019 to 2020. This trend is evident globally, supported by studies conducted in various countries, including the UK, Brazil, Norway, USA, Australia, and Germany.	[27,167–172]		
	– Factors contributing to the growing consumption of PBMS include health considerations, as well as concerns regarding animal welfare, greenhouse gas emissions, and the broader environmental impacts associated with meat production.	[173,174]		
Microalgae	– Rapid growth in diverse habitats under conditions that support photosynthetic growth.	[175]	– Lack of awareness regarding the health benefits of their use, minimal incentives for producers.	[175]
	– Cultivation in closed systems or open ponds without the use of plant protection agents and pesticides.	[175]	– Difficulties regarding economic profitability.	[175]
	– High tolerance to environmental conditions—microalgae demonstrate greater productivity compared to conventional crops and can be cultivated in both different climates and extreme pH and salt concentrations.	[175]	– Enhanced biomass concentration, coupled with ample feedstock availability for extracting desired products, can be realized through high-density agricultural practices.	[176]
	– They utilize nutrients present in wastewater, thereby reducing the reliance on chemical inputs and freshwater.	[175]	– Unattractive taste, smell, and color, which completely alter the organoleptic properties of processed food.	[177]
	– Microalgae have a unique capacity to accumulate essential nutrients and bioactive compounds crucial for human health.	[178]	– Microalgae have intricate cell walls composed of layers including pectin, cellulose, alginate, fibrillar peptidoglycan, and various polysaccharides (such as cellulose and hemicellulose), which may adversely affect bioavailability.	[179]
	– Microalgae contain up to 50–70% protein in dry mass. Moreover, they are rich sources of vitamins, beta-carotene and polyunsaturated fats, vitamins, and beta-carotene.	[175]		

Table 2. *Cont.*

Alternative Protein Sources	Advantages and Development Potential	Reference	Barriers and Risks	Reference
Insects	– Edible insects, particularly those belonging to the order Orthoptera, are a rich source of protein, containing between 48% and 77% protein content. They also provide all essential amino acids necessary for maintaining a balanced and healthy diet.	[180–182]	– Insects can be either scavengers or parasites, primarily consuming grains, which may result in them carrying various pathogens.	[183]
	– Insects produce less pollution and residue compared to other vertebrates in traditional farming.	[181]	– The level and scope of contamination in insect-based food products are primarily determined by the insect species, the substrates or feed used in breeding colonies, the production methods, and the stage at which the insects are harvested.	[184]
	– Given insects' minimal needs for water, land, and energy, their production is economically efficient. Since insects are poikilothermic, they can derive water from the moisture in their food. For instance, crickets require only 1.5 L of water to produce one kilogram of protein, whereas beef requires a substantial 3400 L for the same quantity of protein.	[181]	– Potential risks associated with consuming edible insects include consuming insects in inappropriate developmental stages, improper handling, and inadequate culinary processing.	[185]
	– By consuming organic waste and by-products, insects can process them into high-value food for humans or feed for animals, reducing land space for their production.	[181]	– For insect-derived foods, concerns arise regarding the consumption of vegetation/crops sprayed with pesticides, which may lead to pesticide bioaccumulation in their tissues.	[184]
	– They require six times less feed than cattle.	[186]	– Food neophobia, the fear or reluctance to try new or unfamiliar foods, plays a substantial role in influencing consumer acceptance of food products containing insects.	[187]
			– The taste and aroma of insects vary greatly, influenced by factors such as pheromones released, the habitat where insects reside, and the diet they ingest.	[188]
			– Allergies can result from the substantial chitin content present in insect exoskeletons. Responsible for allergies are certain types of enzymes in insects (arginine kinase).	[181,189]
			– Another concern is the potential for cross-reactivity between different species of insects.	[190]
			– Accumulation of heavy metals, particularly lead and cadmium, in insects varies depending on factors such as the insect's feed, species, and growth stage.	[191]
Cultivated meat	– Cultured meat reserves can be manufactured with lower environmental impacts compared to traditional meat production methods.	[192]	– Large-scale processes for lab-grown meat are not currently operational. The availability and efficiency of selecting raw materials for culture media in necessary quantities are uncertain. Additionally, there is ambiguity surrounding the supply scale of growth factors, vitamins, minerals, and trace elements.	[173]
	– Production cultured meat can reduce water consumption, eutrophication potential, land use, and energy requirements.	[150]	– Despite expectations that consumers will support noninvasive meat production technologies that ensure improved health and meat quality, consumers approach such products with caution.	[69]
	– It possesses a desirable lipid profile (is free from cholesterol and contains low levels of saturated fatty acids).	[193]	– Moreover, socio-cultural differences play a critical role in influencing consumer responses to emerging food technologies.	[105]
	– Laboratory-grown meat is less susceptible to many microbiological and chemical hazards thanks to standardized production methods.	[193,194]	– High expectations for sensory attributes, along with the high cost, present significant barriers to the advancement of lab-grown meat production. The taste of traditional meat is challenging to replicate in lab-grown meat.	[105,193,195]
			– Cell-cultured hamburger meat would be priced at over $100 per kilogram for consumers. Most of production costs, about 85%, stem from expenses related to bioreactors, labor, and equipment. In addition to economic feasibility, certain technical challenges also hinder progress.	[196,197]

Table 2. *Cont.*

Alternative Protein Sources	Advantages and Development Potential	Reference	Barriers and Risks	Reference
Mushrooms	– Mycoprotein includes all essential amino acids and boasts a net protein utilization similar to that of milk. Additionally, it supplies various minerals like iron, selenium, manganese, sodium, phosphorus, calcium and vitamin B_2. Consuming mycoprotein reduces energy intake, which is especially advantageous for obese and overweight individuals, and is instrumental in promoting muscle protein synthesis in young individuals.	[198–200]	– Concerns regarding the consumption of mycoproteins include the production of microbiological toxins and the potential for allergies.	[201]
	– Life cycle assessments of mycoprotein production demonstrate reduced greenhouse gas emissions compared to both plant and animal proteins.	[202]	– Preliminary studies indicate that mycoprotein production requires substantial amounts of energy and high-quality raw materials (e.g., sugar), resulting in a significant impact on greenhouse gas emissions and energy consumption.	[203]
	– The global consumption of mycoprotein is on the rise due to its favorable nutritional profile.	[201]		
	– For instance, including mycoprotein in the diet regulates blood insulin level and influences human digestive processes by delaying gastric emptying and intestinal motility.	[204]		
	– Mycoprotein consumption improves blood cholesterol, promotes healthy muscle growth, and reduces calories intake in individuals who are lean, obese, and overweight.	[199,200,205–207]		

From a sustainability perspective, the production of meat substitutes appears to be superior to conventional meat [150,151]. Meat substitutes necessitate less land area and generate significantly lower levels of greenhouse gases. This production approach is more suitable for adapting to climate changes impacting animal production, such as higher temperatures resulting in diminished feed conversion rates, decreased weight gain, and reduced reproductive success. The long-term advantage of cultured meat could arise from the availability of decarbonized energy sources [152,153].

Various categories of alternative proteins have been commercialized, including plant-based AP, algae, fungi, insects, etc. [154]. However, alternative proteins derived through cellular agriculture still encounter challenges related to scaling and achieving widespread commercialization [155,156].

Due to environmental and health concerns, there is a growing demand for meat analogs. The primary challenge lies in developing meat analogs that replicate the nutritional and sensory properties of traditional meat [157]. Meat analogs fall into several categories: cultured meat (produced from in vitro cell or tissue cultures), modified meat (involving genetically modified organisms (GMOs)), and meat analogs derived from plant sources such as soy protein or single-cell protein extracted from cultivated microbial biomass of bacteria, fungi, microalgae, and yeast [201,208–212]. Technical and scientific challenges hinder the widespread adoption and commercialization of cultured meat. Consumer acceptance and regulatory frameworks are crucial for future advancements. Multidisciplinary collaboration among scientists, social science researchers, economists, and marketing experts is essential to obtain the social and legal space for CM/CF/CS products' acceptance [155].

The innovation process in the industry is tied to the availability of new products on the market. To create consumer demand, introducing new food products must combine technological innovations with a range of social and environmental changes, both large and small [213].

In Europe, the demand for plant-based protein will increase to EUR 7.16 billion by 2030, with a compound annual growth rate of 8.9% between 2023 and 2030. There is also a growing demand for plant-based milk substitutes and plant-based meat substitutes, which are likely to at least partially replace animal-based foods [214]. The search for new products, so-called plant-based meat, aims to make plant-based products more similar to a tasty experience similar to meat by matching product features such as taste, color, and texture. The result of such actions may be to attract and convince carnivorous consumers of the attractiveness of such products. However, the main challenge of the global market is to reach this group—omnivores—because they are a group more susceptible to dietary changes and can themselves be an example for skeptics [33].

Replacing animal-based protein may lead to a reduction in the amount of other important nutrients contained in animal-based foods. Pellinen et al. (2021) in a 12-week study of partial replacement of animal protein foods with plant protein foods found decreased levels of vitamin B_{12} and iodine [215,216]. Beef, milk, eggs, and mackerel are rich sources of Fe, Ca, vitamin A, and vitamin B_{12}. A significant proportion of Fe in beef is in the heme form and has higher bioavailability than non-heme Fe found in plant foods [217], Ca in milk (and dairy products) becomes bioavailable in the gastrointestinal tract, while phytate in some plant foods can significantly limit the absorption of Ca, Fe, and Zn [214].

Plant-based products made from various row materials (e.g., soy, wheat, pea protein, mushrooms, beans, and lentils) have become increasingly popular. These products emulate the role of meat and seafood in the diet, offering consumers viable options to transition to a diet with lower meat and seafood consumption [218].

Plant-based alternative foods (PBAF) serve as a method to facilitate acceptance of changes in traditional meal structures and the development of new culinary skills necessary for transitioning away from animal-based products in the UK and other countries that have strong culinary traditions centered around meat and meat products [219]. PBAF, utilizing plant proteins such as soy, peas, nuts, oats, and mycoproteins, replicate the taste and texture of animal-based counterparts such as meat, milk, and dairy products. They are steadily gaining market share in the UK, with numerous major supermarkets expanding their selection of these products [27].

Transitioning to a high intake of plant-based foods and significantly reducing animal-based foods remains a key priority. Recommendations for a healthy and sustainable diet include significantly reducing meat consumption, particularly in high-income countries [74,220]. Reducing meat consumption positively impacts all areas of sustainability, including health, environment, biodiversity conservation, society, economy, and culture [221–225].

While vegetarians and vegans make up a small percentage of the population [226,227], and strict elimination of meat may not be feasible or necessary for most consumers, their dietary choices should be viewed as an initial step toward reducing meat consumption among those who prioritize sustainable eating [102]. Consumer segments, including omnivores (meat-eaters) and flexitarians (those who reduce meat consumption), make up a significantly larger proportion of the population in many developed countries. Understanding the motivations of omnivores and flexitarians is crucial for implementing meaningful, long-term changes towards reduced meat consumption in developed countries [228].

The meat substitute industry needs to convince consumers of the product's value relative to its price and raise awareness of the benefits (taste, safety, health) and social benefits (environmental protection, food safety) it offers [70]. Cellular meat combines tissue engineering and cell culture to produce muscle tissue for food production, offering a more sustainable approach that respects animal welfare and reduces or eliminates antibiotics. Cell-based production also reduces the risk of chemical contamination, food-borne illnesses, and zoonotic diseases (*E. coli*, *Campylobacter* spp., and *Salmonella* spp.) compared to conventional meat [229].

Promoting in vitro meat could help reduce deforestation and support long-term environmental sustainability. Additionally, it can restore endangered animals to their ecosystems. The conventional global trade in rare and endangered animal meat is alarming and has depleted wild populations of many rare species in numerous countries [150].

Selected insect species are edible either in their entirety or as ingredients in processed food products. Entomophagy (insect consumption) has a long history that spans many cultures and is still practiced in selected regions, particularly in developing countries. Edible insects are commonly consumed by about one-third of the world's population, especially in Africa, Asia, and South America [230]. Although insect-based food is not part of the Western diet, its farming and utilization as food and feed are expected to increase [231]. Insect-based food and feed are emerging parts of the agricultural sector, with insect protein production in Europe projected to reach up to 3 million tons by 2030 [232–235].

Insects can be used to prepare biscuits [236–238], snacks [239], enriched cornmeal [240], various breads [241–243], meat pies [244], and sausages [245]. Beetle powder [246] can be used to supplement wheat-based pasta. These food products are characterized by a higher protein content and better protein quality than their conventional counterparts [182,247–251]. Several studies have found the acceptability of cookies, honey paste, extruded rice products, crackers, and similar preparations with insects (whole or parts of them) directly detectable [239,252–257]. Although almost completely unexplored, food insects often exhibit a good taste and flavor similar to walnuts, hazelnuts, almonds, or shrimp and shellfish [258]. Given that insect consumption is not familiar to Western consumers [257,259,260], future research should focus on increasing the acceptability of edible insects. Another issue is the food safety of insects, whether collected in the wild or in cultivated fields. Direct or cross-reactivity (crustaceans) to insect allergens appears to be related to insect species [261,262], but processing of insect proteins can significantly reduce [263] the impact of this phenomenon.

Production of single-cell proteins offers several advantages over animal or plant proteins. It is independent of agriculture or climate, not affected by seasonal fluctuations, and does not necessitate arable land or freshwater resources. SCP facilities can be established virtually anywhere and have the potential for continuous operation [264,265]. Microorganisms can thrive on a diverse array of substrates, including low-cost waste materials (e.g., food waste, by-products of food processing, sewage, agricultural and forestry waste), CO_2, or methane [266–268]. The stability and efficiency of production processes are considered environmentally friendly, and microbial biomass represents a dependable alternative for ensuring future food security while mitigating the impact on global sustainable development [267,269].

SCPs are rich in proteins, often reaching up to 80% on a dry mass [266], and typically include lipids, carbohydrates, as well as various vitamins and minerals [265,270]. SCPs offer superior nutritional value compared to both animal and plant proteins [209,210].

SCPs are highly concentrated in proteins, up to 80% on a dry weight basis [266], and typically contain lipids, carbohydrates, and several vitamins and minerals [265,270]. SCPs possess superior nutritional value compared to animal or plant proteins [258,270]. Microorganisms that have been used to produce SCPs for human consumption, mainly including algae and fungi. Bacterial SCPs are currently predominantly used for feed applications but may potentially be utilized for food purposes in the future [266]. Autotrophic bacteria, which directly assimilate CO_2 as a carbon source, are receiving considerable attention in this regard [268,271,272].

The protein content in SCPs varies depending on the microbial species [267]. Growth conditions, including the substrate used, significantly impact microbial metabolism and the characteristics of SCP (protein content and amino acid profile) [273]. Generally, SCP production yields 50–80% protein content from bacteria and 20–60% from yeast [266,271].

Fungal proteins differ in nutritional profiles, lower production costs, and greater environmental benefits compared to plant and animal proteins. Filamentous fungi can be cultivated on inexpensive substrates, typically by-products and waste from food processing (e.g., sugarcane bagasse for *Penicillium janthinellum* cultivation), and forestry and agricultural activities [201,274,275]. Fermentation using edible filamentous fungi enhances the nutritional value of food. Mycoprotein production as an alternative to plant- or animal-based food production offers significant environmental benefits, including low environmental degradation, reduction/reuse of agri-food waste, decentralized production, and reduced greenhouse gas (GHG) emissions [198,201].

Cultural limitations in Western countries pose a challenge to the acceptance of filamentous fungi, some microalgae, and insects as part of the diet. Increasing knowledge about safety, nutrition, and health-promoting characteristics, along with informational campaigns, can help increase consumer acceptance [154].

Yeast protein biomass, with its high protein content and wide spectrum of amino acids, offers nutritional benefits as a dietary supplement for humans [276]. It is particularly recommended for vegan and vegetarian diets, individuals avoiding meat consumption, and adolescents during their developmental period [277]. Yeast protein can be certified by recognized halal and kosher organizations.

Agri-food by-product can serve as a nutrient source for mycoprotein production. In a specific study, date waste was utilized as a fermentation substrate for *F. venenatum*. The resulting mycoproteins did not induce allergic reactions, showed no expression of the fumonisin gene in the starter culture, and were free from mycotoxins such as zearalenone and deoxynivalenol in the fermentation medium. However, the fermentation process did reveal low levels of arsenic, lead, and cadmium [278]. Future research may explore the use of other waste materials for their potential in mycoprotein production.

However, considering that conventional food is cheaper than healthy alternatives and price is one of the most important factors in consumer decision-making, several strategies should be implemented simultaneously. This means reducing the cost of healthy food for consumers and providing dietary incentives, while introducing taxes to reduce the consumption of unhealthy and unsustainable food [279]. Young people show great interest in social media and mobile games, and their interaction is the basis for driving additional consumption motivation in young consumers [280]. The use of social media and gamification strategies can increase the effectiveness of their impact [281,282]. Due to the increasing global environmental problems such as global warming and climate change, environmental degradation, and pollution, sustainable consumption behavior has become one of the most important issues in the market as well as a research area in the last few decades. These problems can be alleviated by changing human behavior in a more environmentally sustainable way. Moreover, sustainable consumption behavior (buying and consuming products in an environmentally friendly way) is considered a prerequisite for promoting sustainable development. Changing unsustainable consumption habits is crucial to realizing the vision of sustainable development. Moreover, all EU Member States have committed to achieving sustainable consumption as part of promoting the Sustainable Development Goals [283,284].

6. Conclusions

Intensive food production significantly impacts environmental degradation, and the necessity to increase production to meet the growing population's food demand will exacerbate these effects. Climate change and emerging extreme weather phenomena will complicate the stability of food production conditions, potentially intensifying food supply issues such as hunger or malnutrition in poorer regions of the globe. Traditional dietary patterns based on animal-derived raw materials, highly processed foods, and unbalanced high-energy diets with mineral and vitamin deficiencies contribute to the development of lifestyle diseases. Applying sustainable development principles is imperative to mitigate these negative impacts on the environment and human health. This includes reducing CO_2 emissions, protecting water and soil quality, and preserving biodiversity.

Promoting sustainable and ethically justified alternatives to traditional methods of meat production and consumption is of paramount importance. Achieving sustainable development goals requires building a value system and changing human awareness, which will affect both food production and consumption levels. Awareness of the importance of sustainable development attributes at the product level or subjective knowledge about the environment makes consumers more inclined to engage in environmentally conscious shopping. Promoting a transition to diets typically rich in plant-based foods and whole proteins while low in animal-based foods will benefit human health and environmental sustainability. The evolution of agricultural policy and investments in research and development of products should bring about new technologies and products, which, along with changes in dietary patterns such as the growing vegan population, can potentially help reduce the environmental impact of food production. In summary, sustainable methods of agricultural production or animal breeding using modern technologies should play a greater role in limiting the negative impact of agriculture on the environment in countries with low acceptance of alternative protein sources. On the other hand, in other countries where there is interest in alternative protein sources, an appropriate pricing strategy is necessary to increase the demand for healthier alternatives to animal products, creating incentives for interested, less affluent consumers. On the other hand, it should be expected that the direction of introducing additional fees for unhealthy products will be implemented in parallel. Additionally, technologies for alternative protein source production can significantly support sustainable food production systems. The gradual change in consumer awareness towards sustainable food will also change the perception of alternative protein sources, which are currently treated with reserve by most consumers. However, developing technologies for the production of alternative protein sources makes a lot of sense as a way to supplement the food deficit, e.g., in the case of natural or man-made disasters. These technologies also create the possibility of producing protein in isolation from the external environment, in a limited area, e.g., in areas with an extremely unfavorable climate for traditional food production, or as a way to reduce the costs of space missions related to transport costs and obtaining food in space.

Author Contributions: Conceptualization: M.G. and M.R.; methodology: M.G. and M.R.; formal analysis: M.G.; data curation: R.S.; literature research: R.S., M.R., M.G., A.K., W.H.H. and D.D.; writing—original draft preparation: M.G.; writing—review and editing: M.R., M.G. and D.D.; project administration: P.D.-K. and A.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: This study did not involve any testing on humans or live animals.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors on request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Echegaray, N.; Hassoun, A.; Jagtap, S.; Tetteh-Caesar, M.; Kumar, M.; Tomasevic, I.; Goksen, G.; Lorenzo, J.M. Meat 4.0: Principles and Applications of Industry 4.0 Technologies in the Meat Industry. *Appl. Sci.* **2022**, *12*, 6986. [CrossRef]
2. Handral, H.K.; Tay, S.H.; Chan, W.W.; Choudhury, D. 3D Printing of Cultured Meat Products. *Crit. Rev. Food Sci. Nutr.* **2022**, *62*, 272–281. [CrossRef] [PubMed]
3. Barbut, S. Meat Industry 4.0: A Distant Future? *Anim. Front.* **2020**, *10*, 38–47. [CrossRef] [PubMed]
4. Faber, I.; Castellanos-Feijoó, N.A.; de Sompel, L.V.; Davydova, A.; Perez-Cueto, F.J.A. Attitudes and Knowledge towards Plant-Based Diets of Young Adults across Four European Countries. Exploratory Survey. *Appetite* **2020**, *145*, 104498. [CrossRef] [PubMed]
5. Kantono, K.; Hamid, N.; Malavalli, M.M.; Liu, Y.; Liu, T.; Seyfoddin, A. Consumer Acceptance and Production of In Vitro Meat: A Review. *Sustainability* **2022**, *14*, 4910. [CrossRef]
6. Beaudoin, A.; Rabl, V.; Rupanagudi, R.; Sheikh, N. *Reducing the Consumer Rejection of Cultivated Meat*; London School of Economics and Political Science: London, UK, 2018.
7. Searchinger, T.D.; Wirsenius, S.; Beringer, T.; Dumas, P. Assessing the Efficiency of Changes in Land Use for Mitigating Climate Change. *Nature* **2018**, *564*, 249–253. [CrossRef] [PubMed]
8. Food and Agriculture Organization of the United Nations. *World Livestock: Transforming the Livestock Sector through the Sustainable Development Goals*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2018; ISBN 92-5-130883-7.
9. Gerber, P.J.; Steinfeld, H.; Henderson, B.; Mottet, A.; Opio, C.; Dijkman, J.; Falcucci, A.; Tempio, G. *Tackling Climate Change through Livestock: A Global Assessment of Emissions and Mitigation Opportunities*; Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, 2013; ISBN 92-5-107920-X.
10. Chan, F.K.S.; Zhu, Y.-G.; Wang, J.; Chen, J.; Johnson, M.F.; Li, G.; Chen, W.-Q.; Wang, L.; Li, P.; Wang, J. Food Security in Climatic Extremes: Challenges and Opportunities for China. *Cell Rep. Sustain.* **2024**, *1*, 100013. [CrossRef]
11. Berners-Lee, M.; Kennelly, C.; Watson, R.; Hewitt, C.N. Current Global Food Production Is Sufficient to Meet Human Nutritional Needs in 2050 Provided There Is Radical Societal Adaptation. *Elem. Sci. Anthr.* **2018**, *6*, 52. [CrossRef]
12. United Nations. *The Sustainable Development Goals Report 2023. Special Edition. Towards a Rescue Plan for People and Planet*; UNSD: New York, NY, USA, 2023.
13. Liu, L.; Plail, M. Toward Sustainable and Resilient Food Systems. *Cell Rep. Sustain.* **2024**, *1*, 100031. [CrossRef]
14. Burlingame, B.; Charrondiere, U.R.; Dernini, S.; Stadlmayr, B.; Mondovì, S. Food Biodiversity and Sustainable Diets: Implications of Applications for Food Production and Processing. In *Green Technologies in Food Production and Processing*; Springer: Berlin/Heidelberg, Germany, 2012; pp. 643–657.

15. Gialeli, M.; Troumbis, A.Y.; Giaginis, C.; Papadopoulou, S.K.; Antoniadis, I.; Vasios, G.K. The Global Growth of ‘Sustainable Diet’ during Recent Decades, a Bibliometric Analysis. *Sustainability* **2023**, *15*, 11957. [CrossRef]
16. Çakmakçı, R.; Salık, M.A.; Çakmakçı, S. Assessment and Principles of Environmentally Sustainable Food and Agriculture Systems. *Agriculture* **2023**, *13*, 1073. [CrossRef]
17. Fantini, A. Urban and Peri-Urban Agriculture as a Strategy for Creating More Sustainable and Resilient Urban Food Systems and Facing Socio-Environmental Emergencies. *Agroecol. Sustain. Food Syst.* **2023**, *47*, 47–71. [CrossRef]
18. Lucertini, G.; Di Giustino, G. Urban and Peri-Urban Agriculture as a Tool for Food Security and Climate Change Mitigation and Adaptation: The Case of Mestre. *Sustainability* **2021**, *13*, 5999. [CrossRef]
19. Lynch, J.; Cain, M.; Frame, D.; Pierrehumbert, R. Agriculture's Contribution to Climate Change and Role in Mitigation Is Distinct from Predominantly Fossil CO_2-Emitting Sectors. *Front. Sustain. Food Syst.* **2021**, *4*, 518039. [CrossRef] [PubMed]
20. Zimmerer, K.S.; Bell, M.G.; Chirisa, I.; Duvall, C.S.; Egerer, M.; Hung, P.-Y.; Lerner, A.M.; Shackleton, C.; Ward, J.D.; Yacamán Ochoa, C. Grand Challenges in Urban Agriculture: Ecological and Social Approaches to Transformative Sustainability. *Front. Sustain. Food Syst.* **2021**, *5*, 668561. [CrossRef]
21. Conway, G. *The Doubly Green Revolution: Food for All in the Twenty-First Century*; Cornell University Press: Ithaca, NY, USA, 1998; ISBN 0-8014-8610-6.
22. Qu, B.; Xiao, Z.; Upadhyay, A.; Luo, Y. Perspectives on Sustainable Food Production System: Characteristics and Green Technologies. *J. Agric. Food Res.* **2024**, *15*, 100988. [CrossRef]
23. Machovina, B.; Feeley, K.J.; Ripple, W.J. Biodiversity Conservation: The Key Is Reducing Meat Consumption. *Sci. Total Environ.* **2015**, *536*, 419–431. [CrossRef] [PubMed]
24. Willet, W.; Rockström, J.; Loken, B.; Springmann, M.; Lang, T.; Vermeulen, S.; Garnett, T.; Tilman, D.; DeClerck, F.; Wood, A. Food in the Anthropocene: The EAT–Lancet Commission on Healthy Diets from Sustainable Food Systems. *EAT Lancet* **2019**, *393*, 447–492. [CrossRef]
25. Shukla, P.R.; Skeg, J.; Calvo Buendia, E.; Masson-Delmotte, V.; Pörtner, H.-O.; Roberts, D.C.; Zhai, P.; Slade, R.; Connors, S.; van Diemen, S.; et al. Climate Change and Land: An IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems. 2019. Available online: https://www.ipcc.ch/srccl/ (accessed on 14 July 2024).
26. FAO (Food and Agriculture Organization of the United Nations). AQUASTAT–FAO's Global Information System on Water and Agriculture, Database. 2024. Available online: https://www.fao.org/aquastat/en/ (accessed on 17 June 2024).
27. Alae-Carew, C.; Green, R.; Stewart, C.; Cook, B.; Dangour, A.D.; Scheelbeek, P.F.D. The Role of Plant-Based Alternative Foods in Sustainable and Healthy Food Systems: Consumption Trends in the UK. *Sci. Total Environ.* **2022**, *807*, 151041. [CrossRef]
28. Vanham, D.; Leip, A.; Galli, A.; Kastner, T.; Bruckner, M.; Uwizeye, A.; Van Dijk, K.; Ercin, E.; Dalin, C.; Brandão, M. Environmental Footprint Family to Address Local to Planetary Sustainability and Deliver on the SDGs. *Sci. Total Environ.* **2019**, *693*, 133642. [CrossRef]
29. Cordeiro, M.R.C.; Mengistu, G.F.; Pogue, S.J.; Legesse, G.; Gunte, K.E.; Taylor, A.M.; Ominski, K.H.; Beauchemin, K.A.; McGeough, E.J.; Faramarzi, M.; et al. Assessing Feed Security for Beef Production within Livestock-Intensive Regions. *Agric. Syst.* **2022**, *196*, 103348. [CrossRef]
30. Davis, R.; Watts, P. 4. Water Requirements. In *Feedlot Design and Construction Feedlot Design and Construction*; Meat & Livestock Australia Ltd.: Sydney, NSW, Australia, 2016.
31. Ferrari, L.; Panaite, S.-A.; Bertazzo, A.; Visioli, F. Animal- and Plant-Based Protein Sources: A Scoping Review of Human Health Outcomes and Environmental Impact. *Nutrients* **2022**, *14*, 5115. [CrossRef] [PubMed]
32. Springmann, M.; Wiebe, K.; Mason-D'Croz, D.; Sulser, T.B.; Rayner, M.; Scarborough, P. Health and Nutritional Aspects of Sustainable Diet Strategies and Their Association with Environmental Impacts: A Global Modelling Analysis with Country-Level Detail. *Lancet Planet. Health* **2018**, *2*, e451–e461. [CrossRef]
33. Deprá, M.C.; Dias, R.R.; Sartori, R.B.; de Menezes, C.R.; Zepka, L.Q.; Jacob-Lopes, E. Nexus on Animal Proteins and the Climate Change: The Plant-Based Proteins Are Part of the Solution? *Food Bioprod. Process.* **2022**, *133*, 119–131. [CrossRef]
34. Fresán, U.; Sabaté, J. Vegetarian Diets: Planetary Health and Its Alignment with Human Health. *Adv. Nutr.* **2019**, *10*, S380–S388. [CrossRef] [PubMed]
35. Bouvard, V.; Loomis, D.; Guyton, K.Z.; Grosse, Y.; Ghissassi, F.E.; Benbrahim-Tallaa, L.; Guha, N.; Mattock, H.; Straif, K. Carcinogenicity of Consumption of Red and Processed Meat. *Lancet Oncol.* **2015**, *16*, 1599–1600. [CrossRef]
36. Micha, R.; Wallace, S.K.; Mozaffarian, D. Red and Processed Meat Consumption and Risk of Incident Coronary Heart Disease, Stroke, and Diabetes Mellitus. *Circulation* **2010**, *121*, 2271–2283. [CrossRef]
37. Lima, M.; Costa, R.; Rodrigues, I.; Lameiras, J.; Botelho, G. A Narrative Review of Alternative Protein Sources: Highlights on Meat, Fish, Egg and Dairy Analogues. *Foods* **2022**, *11*, 2053. [CrossRef]
38. European Commission. *Sustainable Development: EU Sets Out Its Priorities*; European Commission: Maastricht, The Netherlands, 2016.
39. Schulze, M.; Janssen, M. Self-Determined or Non-Self-Determined? Exploring Consumer Motivation for Sustainable Food Choices. *Sustain. Prod. Consum.* **2024**, *45*, 57–66. [CrossRef]
40. Onyeaka, H.; Ghosh, S.; Obileke, K.; Miri, T.; Odeyemi, O.A.; Nwaiwu, O.; Tamasiga, P. Preventing Chemical Contaminants in Food: Challenges and Prospects for Safe and Sustainable Food Production. *Food Control* **2024**, *155*, 110040. [CrossRef]

41. Jónsdóttir, S.; Gísladóttir, G. Land Use Planning, Sustainable Food Production and Rural Development: A Literature Analysis. *Geogr. Sustain.* **2023**, *4*, 391–403. [CrossRef]
42. Dönmez, D.; Isak, M.A.; İzgü, T.; Şimşek, Ö. Green Horizons: Navigating the Future of Agriculture through Sustainable Practices. *Sustainability* **2024**, *16*, 3505. [CrossRef]
43. Yu, T.; Mahe, L.; Li, Y.; Wei, X.; Deng, X.; Zhang, D. Benefits of Crop Rotation on Climate Resilience and Its Prospects in China. *Agronomy* **2022**, *12*, 436. [CrossRef]
44. Khor, L.Y.; Tran, N.; Shikuku, K.M.; Campos, N.; Zeller, M. Economic and Productivity Performance of Tilapia and Rohu Carp Polyculture Systems in Bangladesh, Egypt, and Myanmar. 2022. Available online: https://www.researchgate.net/publication/358086171_Economic_and_productivity_performance_of_tilapia_and_rohu_carp_polyculture_systems_in_Bangladesh_Egypt_and_Myanmar (accessed on 14 July 2024).
45. Schellhorn, N.A.; Sork, V.L. The Impact of Weed Diversity on Insect Population Dynamics and Crop Yield in Collards, Brassica Oleraceae (Brassicaceae). *Oecologia* **1997**, *111*, 233–240. [CrossRef] [PubMed]
46. Monteiro, A.; Santos, S.; Gonçalves, P. Precision Agriculture for Crop and Livestock Farming—Brief Review. *Animals* **2021**, *11*, 2345. [CrossRef] [PubMed]
47. Cheruku, J.K.; Katekar, V. Harnessing Digital Agriculture Technologies for Sustainable Agriculture in India: Opportunities and Challenges. *Adm. Dev. J. HIPA Shiml* **2021**, *VIII*, 215–230. [CrossRef]
48. D'Silva, J.L.; Ismail, I.A.; Dahalan, D.; Zaremohzzabieh, Z.; Krauss, S.E. Insights into Developing 3D Visualization Technology to Enhance Gen Y Engagement in Agriculture. *Int. J. Acad. Res. Bus. Soc. Sci.* **2021**, *11*, 185–196. [CrossRef]
49. Degani, O.; Movshowitz, D.; Dor, S.; Meerson, A.; Goldblat, Y.; Rabinovitz, O. Evaluating Azoxystrobin Seed Coating against Maize Late Wilt Disease Using a Sensitive qPCR-Based Method. *Plant Dis.* **2019**, *103*, 238–248. [CrossRef]
50. Perakis, K.; Lampathaki, F.; Nikas, K.; Georgiou, Y.; Marko, O.; Maselyne, J. CYBELE–Fostering Precision Agriculture & Livestock Farming through Secure Access to Large-Scale HPC Enabled Virtual Industrial Experimentation Environments Fostering Scalable Big Data Analytics. *Comput. Netw.* **2020**, *168*, 107035.
51. Ranjha, M.M.A.N.; Shafique, B.; Khalid, W.; Nadeem, H.R.; Mueen-ud-Din, G.; Khalid, M.Z. Applications of Biotechnology in Food and Agriculture: A Mini-Review. *Proc. Natl. Acad. Sci. India Sect. B Biol. Sci.* **2022**, *92*, 11–15. [CrossRef]
52. Tomulescu, C. Microbes in Saline Environments and Their Potential Applications in Sustainable Agriculture. *Chem. Proc.* **2022**, *7*, 7004. [CrossRef]
53. Aroeira, C.N.; Feddern, V.; Gressler, V.; Contreras-Castillo, C.J.; Hopkins, D.L. A Review on Growth Promoters Still Allowed in Cattle and Pig Production. *Livest. Sci.* **2021**, *247*, 104464. [CrossRef]
54. Kuzmina, N.N.; Petrov, O.Y. Meat Qualities of Cross Cobb-500 Broilers Grown with the Use of the Antioxidant Dihydroquercetin. *IOP Conf. Ser. Earth Environ. Sci.* **2021**, *677*, 032074. [CrossRef]
55. Purvis, B.; Mao, Y.; Robinson, D. Three Pillars of Sustainability: In Search of Conceptual Origins. *Sustain. Sci.* **2019**, *14*, 681–695. [CrossRef]
56. United Nations. *The Sustainable Development Goals Report*; UNSD: New York, NY, USA, 2022.
57. European Commission. *The European Green Deal: Striving to Be the First Climate-Neutral Continent*; European Union: Maastricht, The Netherlands, 2024.
58. Kuc-Czarnecka, M.; Markowicz, I.; Sompolska-Rzechuła, A. SDGs Implementation, Their Synergies, and Trade-Offs in EU Countries–Sensitivity Analysis-Based Approach. *Ecol. Indic.* **2023**, *146*, 109888. [CrossRef]
59. Haines, A.; Scheelbeek, P. European Green Deal: A Major Opportunity for Health Improvement. *Lancet* **2020**, *395*, 1327–1329. [CrossRef]
60. Schön, A.-M.; Böhringer, M. Land Consumption for Current Diets Compared with That for the Planetary Health Diet—How Many People Can Our Land Feed? *Sustainability* **2023**, *15*, 8675. [CrossRef]
61. Muscio, A.; Sisto, R. Are Agri-Food Systems Really Switching to a Circular Economy Model? Implications for European Research and Innovation Policy. *Sustainability* **2020**, *12*, 5554. [CrossRef]
62. Veldkamp, T.; Meijer, N.; Alleweldt, F.; Deruytter, D.; Van Campenhout, L.; Gasco, L.; Roos, N.; Smetana, S.; Fernandes, A.; van der Fels-Klerx, H.J. Overcoming Technical and Market Barriers to Enable Sustainable Large-Scale Production and Consumption of Insect Proteins in Europe: A SUSINCHAIN Perspective. *Insects* **2022**, *13*, 281. [CrossRef]
63. Arayess, S.; de Boer, A. How to Navigate the Tricky Landscape of Sustainability Claims in the Food Sector. *Eur. J. Risk Regul.* **2022**, *13*, 643–664. [CrossRef]
64. Granato, D.; Zabetakis, I.; Koidis, A. Sustainability, Nutrition, and Scientific Advances of Functional Foods under the New EU and Global Legislation Initiatives. *J. Funct. Foods* **2023**, *109*, 105793. [CrossRef]
65. Eakin, H.; Connors, J.P.; Wharton, C.; Bertmann, F.; Xiong, A.; Stoltzfus, J. Identifying Attributes of Food System Sustainability: Emerging Themes and Consensus. *Agric. Hum. Values* **2017**, *34*, 757–773. [CrossRef]
66. Hakio, K.; Mattelmäki, T. Future Skills of Design for Sustainability: An Awareness-Based Co-Creation Approach. *Sustainability* **2019**, *11*, 5247. [CrossRef]
67. Anzani, C.; Boukid, F.; Drummond, L.; Mullen, A.M.; Álvarez, C. Optimising the Use of Proteins from Rich Meat Co-Products and Non-Meat Alternatives: Nutritional, Technological and Allergenicity Challenges. *Food Res. Int.* **2020**, *137*, 109575. [CrossRef] [PubMed]

68. Kyriakopoulou, K.; Dekkers, B.; Goot, A.J. van der Chapter 6—Plant-Based Meat Analogues. In *Sustainable Meat Production and Processing*; Galanakis, C.M., Ed.; Academic Press: Cambridge, MA, USA, 2019; pp. 103–126. ISBN 978-0-12-814874-7.
69. Hocquette, J.-F. Is It Possible to Save the Environment and Satisfy Consumers with Artificial Meat? *J. Integr. Agric.* **2015**, *14*, 206–207. [CrossRef]
70. Liu, W.; Hao, Z.; Florkowski, W.J.; Wu, L.; Yang, Z. A Review of the Challenges Facing Global Commercialization of the Artificial Meat Industry. *Foods* **2022**, *11*, 3609. [CrossRef] [PubMed]
71. El Bilali, H.; Callenius, C.; Strassner, C.; Probst, L. Food and Nutrition Security and Sustainability Transitions in Food Systems. *Food Energy Secur.* **2019**, *8*, e00154. [CrossRef]
72. Theurl, M.C.; Lauk, C.; Kalt, G.; Mayer, A.; Kaltenegger, K.; Morais, T.G.; Teixeira, R.F.M.; Domingos, T.; Winiwarter, W.; Erb, K.-H.; et al. Food Systems in a Zero-Deforestation World: Dietary Change Is More Important than Intensification for Climate Targets in 2050. *Sci. Total Environ.* **2020**, *735*, 139353. [CrossRef]
73. Jarmul, S.; Dangour, A.D.; Green, R.; Liew, Z.; Haines, A.; Scheelbeek, P.F. Climate Change Mitigation through Dietary Change: A Systematic Review of Empirical and Modelling Studies on the Environmental Footprints and Health Effects of 'Sustainable Diets'. *Environ. Res. Lett.* **2020**, *15*, 123014. [CrossRef]
74. Springmann, M.; Spajic, L.; Clark, M.A.; Poore, J.; Herforth, A.; Webb, P.; Rayner, M.; Scarborough, P. The Healthiness and Sustainability of National and Global Food Based Dietary Guidelines: Modelling Study. *BMJ* **2020**, *370*, m2322. [CrossRef]
75. Anastasiou, K.; Baker, P.; Hadjikakou, M.; Hendrie, G.A.; Lawrence, M. A Conceptual Framework for Understanding the Environmental Impacts of Ultra-Processed Foods and Implications for Sustainable Food Systems. *J. Clean. Prod.* **2022**, *368*, 133155. [CrossRef]
76. Anastasiou, K.; Baker, P.; Hendrie, G.A.; Hadjikakou, M.; Boylan, S.; Chaudhary, A.; Clark, M.; DeClerck, F.A.J.; Fanzo, J.; Fardet, A.; et al. Conceptualising the Drivers of Ultra-Processed Food Production and Consumption and Their Environmental Impacts: A Group Model-Building Exercise. *Glob. Food Secur.* **2023**, *37*, 100688. [CrossRef]
77. Garzillo, J.M.F.; Poli, V.F.S.; Leite, F.H.M.; Steele, E.M.; Machado, P.P.; da Costa Louzada, M.L.; Levy, R.B.; Monteiro, C.A. Ultra-Processed Food Intake and Diet Carbon and Water Footprints: A National Study in Brazil. *Rev. Saude Publica* **2022**, *56*, 6. [CrossRef] [PubMed]
78. Kesse-Guyot, E.; Allès, B.; Brunin, J.; Fouillet, H.; Dussiot, A.; Berthy, F.; Perraud, E.; Hercberg, S.; Julia, C.; Mariotti, F. Environmental Impacts along the Value Chain from the Consumption of Ultra-Processed Foods. *Nat. Sustain.* **2023**, *6*, 192–202. [CrossRef]
79. da Silva, J.T.; Garzillo, J.M.F.; Rauber, F.; Kluczkovski, A.; Rivera, X.S.; da Cruz, G.L.; Frankowska, A.; Martins, C.A.; Louzada, M.L.d.C.; Monteiro, C.A.; et al. Greenhouse Gas Emissions, Water Footprint, and Ecological Footprint of Food Purchases According to Their Degree of Processing in Brazilian Metropolitan Areas: A Time-Series Study from 1987 to 2018. *Lancet Planet. Health* **2021**, *5*, e775–e785. [CrossRef]
80. García, S.; Pastor, R.; Monserrat-Mesquida, M.; Álvarez-Álvarez, L.; Rubín-García, M.; Martínez-González, M.Á.; Salas-Salvadó, J.; Corella, D.; Fitó, M.; Martínez, J.A.; et al. Ultra-Processed Foods Consumption as a Promoting Factor of Greenhouse Gas Emissions, Water, Energy, and Land Use: A Longitudinal Assessment. *Sci. Total Environ.* **2023**, *891*, 164417. [CrossRef]
81. Nordström, J.; Denver, S. The Impact of Voluntary Sustainability Adjustments on Greenhouse Gas Emissions from Food Consumption—The Case of Denmark. *Clean. Responsible Consum.* **2024**, *12*, 100164. [CrossRef]
82. Prag, A.A.; Henriksen, C.B. Transition from Animal-Based to Plant-Based Food Production to Reduce Greenhouse Gas Emissions from Agriculture—The Case of Denmark. *Sustainability* **2020**, *12*, 8228. [CrossRef]
83. Burlingame, B.; Lawrence, M.; Macdiarmid, J.; Dernini, S.; Oenema, S. IUNS Task Force on Sustainable Diets—LINKING NUTRITION AND FOOD SYSTEMS. *Trends Food Sci. Technol.* **2022**, *130*, 42–50. [CrossRef]
84. Śmiglak-Krajewska, M.; Wojciechowska-Solis, J.; Viti, D. Consumers' Purchasing Intentions on the Legume Market as Evidence of Sustainable Behaviour. *Agriculture* **2020**, *10*, 424. [CrossRef]
85. Dubois, G.; Sovacool, B.; Aall, C.; Nilsson, M.; Barbier, C.; Herrmann, A.; Bruyère, S.; Andersson, C.; Skold, B.; Nadaud, F. It Starts at Home? Climate Policies Targeting Household Consumption and Behavioral Decisions Are Key to Low-Carbon Futures. *Energy Res. Soc. Sci.* **2019**, *52*, 144–158. [CrossRef]
86. Vesterbæk, P.; Preus, N.; Logo-Koefoed, C. Analyse Af Danskernes Syn På Klima Og Bæredygtighed. 2020. Available online: https://www.ernaeringsfokus.dk/media/j0kcebqd/markedsanalyse-baeredygtighed-2020-final.pdf (accessed on 14 July 2024).
87. Annunziata, A.; Agovino, M.; Mariani, A. Measuring Sustainable Food Consumption: A Case Study on Organic Food. *Sustain. Prod. Consum.* **2019**, *17*, 95–107.
88. Baudry, J.; Pointereau, P.; Seconda, L.; Vidal, R.; Taupier-Letage, B.; Langevin, B.; Allès, B.; Galan, P.; Hercberg, S.; Amiot, M.-J. Improvement of Diet Sustainability with Increased Level of Organic Food in the Diet: Findings from the BioNutriNet Cohort. *Am. J. Clin. Nutr.* **2019**, *109*, 1173–1188. [CrossRef]
89. De Bauw, M.; Franssens, S.; Vranken, L. Trading off Environmental Attributes in Food Consumption Choices. *Food Policy* **2022**, *112*, 102338. [CrossRef]
90. Kause, A.; Bruine de Bruin, W.; Millward-Hopkins, J.; Olsson, H. Public Perceptions of How to Reduce Carbon Footprints of Consumer Food Choices. *Environ. Res. Lett.* **2019**, *14*, 114005. [CrossRef]

91. Guiné, R.P.F.; Florença, S.G.; Anjos, O.; Correia, P.M.R.; Ferreira, B.M.; Costa, C.A. An Insight into the Level of Information about Sustainability of Edible Insects in a Traditionally Non-Insect-Eating Country: Exploratory Study. *Sustainability* **2021**, *13*, 12014. [CrossRef]
92. Elhoushy, S.; Lanzini, P. Factors Affecting Sustainable Consumer Behavior in the MENA Region: A Systematic Review. *J. Int. Consum. Mark.* **2021**, *33*, 256–279. [CrossRef]
93. Brock, A.; Williams, I.; Kemp, S. "I'll Take the Easiest Option Please". Carbon Reduction Preferences of the Public. *J. Clean. Prod.* **2023**, *429*, 139398. [CrossRef]
94. Ford, H.; Zhang, Y.; Gould, J.; Danner, L.; Bastian, S.E.P.; Ford, R.; Yang, Q. Applying Regression Tree Analysis to Explore Willingness to Reduce Meat and Adopt Protein Alternatives among Australia, China and the UK. *Food Qual. Prefer.* **2023**, *112*, 105034. [CrossRef]
95. Boereboom, A.; Mongondry, P.; de Aguiar, L.K.; Urbano, B.; Jiang, Z.; de Koning, W.; Vriesekoop, F. Identifying Consumer Groups and Their Characteristics Based on Their Willingness to Engage with Cultured Meat: A Comparison of Four European Countries. *Foods* **2022**, *11*, 197. [CrossRef]
96. Palomo-Vélez, G.; Tybur, J.M.; Vugt, M. van Unsustainable, Unhealthy, or Disgusting? Comparing Different Persuasive Messages against Meat Consumption. *J. Environ. Psychol.* **2018**, *58*, 63–71. [CrossRef]
97. Einhorn, L. Meat Consumption, Classed? *Osterr. Z. Soziologie* **2021**, *46*, 125–146. [CrossRef]
98. Moreira, M.N.B.; da Veiga, C.P.; da Veiga, C.R.P.; Reis, G.G.; Pascuci, L.M. Reducing Meat Consumption: Insights from a Bibliometric Analysis and Future Scopes. *Future Foods* **2022**, *5*, 100120. [CrossRef]
99. Koch, F.; Heuer, T.; Krems, C.; Claupein, E. Meat Consumers and Non-Meat Consumers in Germany: A Characterisation Based on Results of the German National Nutrition Survey II. *J. Nutr. Sci.* **2019**, *8*, e21. [CrossRef] [PubMed]
100. da Veiga, C.P.; Moreira, M.N.B.; da Veiga, C.R.P.; Souza, A.; Su, Z. Consumer Behavior Concerning Meat Consumption: Evidence from Brazil. *Foods* **2023**, *12*, 188. [CrossRef] [PubMed]
101. Kirbiš, A.; Lamot, M.; Javornik, M. The Role of Education in Sustainable Dietary Patterns in Slovenia. *Sustainability* **2021**, *13*, 3036. [CrossRef]
102. Dagevos, H. Finding Flexitarians: Current Studies on Meat Eaters and Meat Reducers. *Trends Food Sci. Technol.* **2021**, *114*, 530–539. [CrossRef]
103. de Gavelle, E.; Davidenko, O.; Fouillet, H.; Delarue, J.; Darcel, N.; Huneau, J.-F.; Mariotti, F. Self-Declared Attitudes and Beliefs Regarding Protein Sources Are a Good Prediction of the Degree of Transition to a Low-Meat Diet in France. *Appetite* **2019**, *142*, 104345. [CrossRef]
104. Minotti, B.; Antonelli, M.; Dembska, K.; Marino, D.; Riccardi, G.; Vitale, M.; Calabrese, I.; Recanati, F.; Giosuè, A. True Cost Accounting of a Healthy and Sustainable Diet in Italy. *Front. Nutr.* **2022**, *9*, 974768. [CrossRef]
105. Verbeke, W.; Sans, P.; Loo, E.J.V. Challenges and Prospects for Consumer Acceptance of Cultured Meat. *J. Integr. Agric.* **2015**, *14*, 285–294. [CrossRef]
106. Verbeke, W.; Marcu, A.; Rutsaert, P.; Gaspar, R.; Seibt, B.; Fletcher, D.; Barnett, J. 'Would You Eat Cultured Meat?': Consumers' Reactions and Attitude Formation in Belgium, Portugal and the United Kingdom. *Meat Sci.* **2015**, *102*, 49–58. [CrossRef] [PubMed]
107. Lizcano-Prada, J.; Maestre-Matos, M.; Mesias, F.J.; Lami, O.; Giray, H.; Özçiçek Dölekoğlu, C.; Abdoulaye Bamoi, A.G.; Martínez-Carrasco, F. Does Consumers' Cultural Background Affect How They Perceive and Engage in Food Sustainability? A Cross-Cultural Study. *Foods* **2024**, *13*, 311. [CrossRef]
108. Caporgno, M.P.; Mathys, A. Trends in Microalgae Incorporation Into Innovative Food Products With Potential Health Benefits. *Front. Nutr.* **2018**, *5*, 58. [CrossRef]
109. Smetana, S.; Mathys, A.; Knoch, A.; Heinz, V. Meat Alternatives: Life Cycle Assessment of Most Known Meat Substitutes. *Int. J. Life Cycle Assess.* **2015**, *20*, 1254–1267. [CrossRef]
110. HLPE. *Nutrition and Food Systems. A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*; FAO: Rome, Italy, 2018.
111. Aleksandrowicz, L.; Green, R.; Joy, E.J.M.; Smith, P.; Haines, A. The Impacts of Dietary Change on Greenhouse Gas Emissions, Land Use, Water Use, and Health: A Systematic Review. *PLoS ONE* **2016**, *11*, e0165797. [CrossRef] [PubMed]
112. Clune, S.; Crossin, E.; Verghese, K. Systematic Review of Greenhouse Gas Emissions for Different Fresh Food Categories. *J. Clean. Prod.* **2017**, *140*, 766–783. [CrossRef]
113. Tziva, M.; Negro, S.O.; Kalfagianni, A.; Hekkert, M.P. Understanding the Protein Transition: The Rise of Plant-Based Meat Substitutes. *Environ. Innov. Soc. Transit.* **2020**, *35*, 217–231. [CrossRef]
114. Springmann, M.; Godfray, H.C.J.; Rayner, M.; Scarborough, P. Analysis and Valuation of the Health and Climate Change Cobenefits of Dietary Change. *Proc. Natl. Acad. Sci. USA* **2016**, *113*, 4146–4151. [CrossRef]
115. Tilman, D.; Clark, M. Global Diets Link Environmental Sustainability and Human Health. *Nature* **2014**, *515*, 518–522. [CrossRef]
116. Bager, S.L.; Persson, U.M.; Reis, T.N.P. dos Eighty-Six EU Policy Options for Reducing Imported Deforestation. *One Earth* **2021**, *4*, 289–306. [CrossRef]
117. Mariotti, F. *Vegetarian and Plant-Based Diets in Health and Disease Prevention*; Academic Press: Cambridge, MA, USA, 2017; ISBN 0-12-803969-8.
118. Jeswani, H.K.; Figueroa-Torres, G.; Azapagic, A. The Extent of Food Waste Generation in the UK and Its Environmental Impacts. *Sustain. Prod. Consum.* **2021**, *26*, 532–547. [CrossRef]
119. Chauhan, C.; Dhir, A.; Akram, M.U.; Salo, J. Food Loss and Waste in Food Supply Chains. A Systematic Literature Review and Framework Development Approach. *J. Clean. Prod.* **2021**, *295*, 126438. [CrossRef]

120. Mokrane, S.; Buonocore, E.; Capone, R.; Franzese, P.P. Exploring the Global Scientific Literature on Food Waste and Loss. *Sustainability* **2023**, *15*, 4757. [CrossRef]
121. Skaf, L.; Franzese, P.; Capone, R.; Buonocore, E. Unfolding Hidden Environmental Impacts of Food Waste: An Assessment for Fifteen Countries of the World. *J. Clean. Prod.* **2021**, *310*, 127523. [CrossRef]
122. Diamantis, D.V.; Shalit, A.; Katsas, K.; Zioga, E.; Zota, D.; Kastorini, C.M.; Veloudaki, A.; Kouvari, M.; Linos, A. Improving Children's Lifestyle and Quality of Life through Synchronous Online Education: The Nutritional Adventures School-Based Program. *Nutrients* **2023**, *15*, 5124. [CrossRef] [PubMed]
123. Asakura, K.; Mori, S.; Sasaki, S.; Nishiwaki, Y. A School-Based Nutrition Education Program Involving Children and Their Guardians in Japan: Facilitation of Guardian-Child Communication and Reduction of Nutrition Knowledge Disparity. *Nutr. J.* **2021**, *20*, 92. [CrossRef] [PubMed]
124. Andueza, N.; Martin-Calvo, N.; Navas-Carretero, S.; Cuervo, M. The ALINFA Intervention Improves Diet Quality and Nutritional Status in Children 6 to 12 Years Old. *Nutrients* **2023**, *15*, 2375. [CrossRef]
125. Teo, C.H.; Chin, Y.S.; Lim, P.Y.; Masrom, S.A.H.; Shariff, Z.M. School-Based Intervention That Integrates Nutrition Education and Supportive Healthy School Food Environment among Malaysian Primary School Children: A Study Protocol. *BMC Public Health* **2019**, *19*, 1427. [CrossRef] [PubMed]
126. Roccaldo, R.; Censi, L.; D'Addezio, L.; Berni Canani, S.; Gennaro, L. A Teachers' Training Program Accompanying the "School Fruit Scheme" Fruit Distribution Improves Children's Adherence to the Mediterranean Diet: An Italian Trial. *Int. J. Food Sci. Nutr.* **2017**, *68*, 887–900. [CrossRef]
127. Kastorini, C.-M.; Critselis, E.; Zota, D.; Coritsidis, A.L.; Nagarajan, M.K.; Papadimitriou, E.; Belogianni, K.; Benetou, V.; Linos, A.; Greek National Dietary Guidelines Scientific Team. National Dietary Guidelines of Greece for Children and Adolescents: A Tool for Promoting Healthy Eating Habits. *Public Health Nutr.* **2019**, *22*, 2688–2699. [CrossRef]
128. Ivanova, D.; Barrett, J.; Wiedenhofer, D.; Macura, B.; Callaghan, M.; Creutzig, F. Quantifying the Potential for Climate Change Mitigation of Consumption Options. *Environ. Res. Lett.* **2020**, *15*, 093001. [CrossRef]
129. Hoek, A.C.; Malekpour, S.; Raven, R.; Court, E.; Byrne, E. Towards Environmentally Sustainable Food Systems: Decision-Making Factors in Sustainable Food Production and Consumption. *Sustain. Prod. Consum.* **2021**, *26*, 610–626. [CrossRef]
130. Deloitte, U. *How Consumers Are Embracing Sustainability: Adoption of Sustainable Lifestyles Is on the Rise, but Consumers Need More Help*; Deloitte: Zürich, Switzerland, 2022.
131. Weinrich, R. Opportunities for the Adoption of Health-Based Sustainable Dietary Patterns: A Review on Consumer Research of Meat Substitutes. *Sustainability* **2019**, *11*, 4028. [CrossRef]
132. Varela, P.; Arvisenet, G.; Gonera, A.; Myhrer, K.S.; Fifi, V.; Valentin, D. Meat Replacer? No Thanks! The Clash between Naturalness and Processing: An Explorative Study of the Perception of Plant-Based Foods. *Appetite* **2022**, *169*, 105793. [CrossRef]
133. Vitale, M.; Giosuè, A.; Vaccaro, O.; Riccardi, G. Recent Trends in Dietary Habits of the Italian Population: Potential Impact on Health and the Environment. *Nutrients* **2021**, *13*, 476. [CrossRef]
134. Marchi, E.D.; Scappaticci, G.; Banterle, A.; Alamprese, C. What Is the Role of Environmental Sustainability Knowledge in Food Choices? A Case Study on Egg Consumers in Italy. *J. Clean. Prod.* **2024**, *441*, 141038. [CrossRef]
135. Lazzarini, G.A.; Visschers, V.H.M.; Siegrist, M. Our Own Country Is Best: Factors Influencing Consumers' Sustainability Perceptions of Plant-Based Foods. *Food Qual. Prefer.* **2017**, *60*, 165–177. [CrossRef]
136. Graça, J.; Truninger, M.; Junqueira, L.; Schmidt, L. Consumption Orientations May Support (or Hinder) Transitions to More Plant-Based Diets. *Appetite* **2019**, *140*, 19–26. [CrossRef] [PubMed]
137. Aschemann-Witzel, J.; Gantriis, R.F.; Fraga, P.; Perez-Cueto, F.J. Plant-Based Food and Protein Trend from a Business Perspective: Markets, Consumers, and the Challenges and Opportunities in the Future. *Crit. Rev. Food Sci. Nutr.* **2021**, *61*, 3119–3128. [CrossRef]
138. Reipurth, M.F.S.; Hørby, L.; Gregersen, C.G.; Bonke, A.; Cueto, F.J.A.P. Barriers and Facilitators towards Adopting a More Plant-Based Diet in a Sample of Danish Consumers. *Food Qual. Prefer.* **2019**, *73*, 288–292. [CrossRef]
139. Wang, Y.; Tibbetts, S.M.; McGinn, P.J. Microalgae as Sources of High-Quality Protein for Human Food and Protein Supplements. *Foods* **2021**, *10*, 3002. [CrossRef]
140. Jetzke, T.; Bovenschulte, M.; Ehrenberg-Silies, S. *Fleisch 2.0–Unkonventionelle Proteinquellen*; Institut für Technikfolgenabschätzung und Systemanalyse (ITAS): Karlsruhe, Germany, 2016.
141. Dupont, J.; Harms, T.; Fiebelkorn, F. Acceptance of Cultured Meat in Germany—Application of an Extended Theory of Planned Behaviour. *Foods* **2022**, *11*, 424. [CrossRef] [PubMed]
142. Estruch, R.; Ros, E.; Salas-Salvadó, J.; Covas, M.-I.; Corella, D.; Arós, F.; Gómez-Gracia, E.; Ruiz-Gutiérrez, V.; Fiol, M.; Lapetra, J.; et al. Primary Prevention of Cardiovascular Disease with a Mediterranean Diet Supplemented with Extra-Virgin Olive Oil or Nuts. *N. Engl. J. Med.* **2018**, *378*, e34. [CrossRef] [PubMed]
143. Gantenbein, K.V.; Kanaka-Gantenbein, C. Mediterranean Diet as an Antioxidant: The Impact on Metabolic Health and Overall Wellbeing. *Nutrients* **2021**, *13*, 1951. [CrossRef]
144. Rees, K.; Takeda, A.; Martin, N.; Ellis, L.; Wijesekara, D.; Vepa, A.; Das, A.; Hartley, L.; Stranges, S. Mediterranean-style Diet for the Primary and Secondary Prevention of Cardiovascular Disease. *Cochrane Database Syst. Rev.* **2019**. [CrossRef]
145. Ventriglio, A.; Sancassiani, F.; Contu, M.P.; Latorre, M.; Di Slavatore, M.; Fornaro, M.; Bhugra, D. Mediterranean Diet and Its Benefits on Health and Mental Health: A Literature Review. *Clin. Pract. Epidemiol. Ment. Health CP & EMH* **2020**, *16*, 156.

146. Theodoridis, X.; Triantafyllou, A.; Chrysoula, L.; Mermigkas, F.; Chroni, V.; Dipla, K.; Gkaliagkousi, E.; Chourdakis, M. Impact of the Level of Adherence to the DASH Diet on Blood Pressure: A Systematic Review and Meta-Analysis. *Metabolites* **2023**, *13*, 924. [CrossRef] [PubMed]
147. Grdeń, P.; Jakubczyk, A. Health Benefits of Legume Seeds. *J. Sci. Food Agric.* **2023**, *103*, 5213–5220. [CrossRef]
148. Kelly, R.; Hanus, A.; Payne-Foster, P.; Calhoun, J.; Stout, R.; Sherman, B.W. Health Benefits of a 16-Week Whole Food, High Fiber, Plant Predominant Diet among U.S. Employees. *Am. J. Health Promot.* **2023**, *37*, 168–176. [CrossRef]
149. Yanni, A.E.; Iakovidi, S.; Vasilikopoulou, E.; Karathanos, V.T. Legumes: A Vehicle for Transition to Sustainability. *Nutrients* **2024**, *16*, 98. [CrossRef]
150. Stephens, N.; Silvio, L.D.; Dunsford, I.; Ellis, M.; Glencross, A.; Sexton, A. Bringing Cultured Meat to Market: Technical, Socio-Political, and Regulatory Challenges in Cellular Agriculture. *Trends Food Sci. Technol.* **2018**, *78*, 155–166. [CrossRef]
151. Rorheim, A.; Mannino, A.; Baumann, T.; Caviola, L. Cultured Meat: An Ethical Alternative to Industrial Animal Farming. *Policy Pap. Sentience Politics* **2016**, *1*, 1–14.
152. Lynch, J.; Pierrehumbert, R. Climate Impacts of Cultured Meat and Beef Cattle. *Front. Sustain. Food Syst.* **2019**, *3*, 421491. [CrossRef]
153. Liu, W.; Hao, Z.; Florkowski, W.J.; Wu, L.; Yang, Z. Assuring Food Security: Consumers’ Ethical Risk Perception of Meat Substitutes. *Agriculture* **2022**, *12*, 671. [CrossRef]
154. Onwezen, M.C.; Bouwman, E.P.; Reinders, M.J.; Dagevos, H. A Systematic Review on Consumer Acceptance of Alternative Proteins: Pulses, Algae, Insects, Plant-Based Meat Alternatives, and Cultured Meat. *Appetite* **2021**, *159*, 105058. [CrossRef] [PubMed]
155. Knežić, T.; Janjušević, L.; Djisalov, M.; Yodmuang, S.; Gadjanski, I. Using Vertebrate Stem and Progenitor Cells for Cellular Agriculture, State-of-the-Art, Challenges, and Future Perspectives. *Biomolecules* **2022**, *12*, 699. [CrossRef] [PubMed]
156. Choudhury, D.; Tseng, T.W.; Swartz, E. The Business of Cultured Meat. *Trends Biotechnol.* **2020**, *38*, 573–577. [CrossRef] [PubMed]
157. Kumar, P.; Chatli, M.K.; Mehta, N.; Singh, P.; Malav, O.P.; Verma, A.K. Meat Analogues: Health Promising Sustainable Meat Substitutes. *Crit. Rev. Food Sci. Nutr.* **2017**, *57*, 923–932. [CrossRef] [PubMed]
158. Collier, E.S.; Normann, A.; Harris, K.L.; Oberrauter, L.-M.; Bergman, P. Making More Sustainable Food Choices One Meal at a Time: Psychological and Practical Aspects of Meat Reduction and Substitution. *Foods* **2022**, *11*, 1182. [CrossRef]
159. Hartmann, C.; Furtwaengler, P.; Siegrist, M. Consumers' Evaluation of the Environmental Friendliness, Healthiness and Naturalness of Meat, Meat Substitutes, and Other Protein-Rich Foods. *Food Qual. Prefer.* **2022**, *97*, 104486. [CrossRef]
160. Macdiarmid, J.I.; Clark, H.; Whybrow, S.; de Ruiter, H.; McNeill, G. Assessing National Nutrition Security: The UK Reliance on Imports to Meet Population Energy and Nutrient Recommendations. *PLoS ONE* **2018**, *13*, e0192649. [CrossRef] [PubMed]
161. González-García, S.; Esteve-Llorens, X.; Moreira, M.T.; Feijoo, G. Carbon Footprint and Nutritional Quality of Different Human Dietary Choices. *Sci. Total Environ.* **2018**, *644*, 77–94. [CrossRef] [PubMed]
162. Lane, M.M.; Davis, J.A.; Beattie, S.; Gómez-Donoso, C.; Loughman, A.; O'Neil, A.; Jacka, F.; Berk, M.; Page, R.; Marx, W.; et al. Ultraprocessed Food and Chronic Noncommunicable Diseases: A Systematic Review and Meta-Analysis of 43 Observational Studies. *Obes. Rev.* **2021**, *22*, e13146. [CrossRef] [PubMed]
163. Farsi, D.N.; Uthumange, D.; Munoz Munoz, J.; Commane, D.M. The Nutritional Impact of Replacing Dietary Meat with Meat Alternatives in the UK: A Modelling Analysis Using Nationally Representative Data. *Br. J. Nutr.* **2022**, *127*, 1731–1741. [CrossRef]
164. Salomé, M.; Huneau, J.-F.; Baron, C.L.; Kesse-Guyot, E.; Fouillet, H.; Mariotti, F. Substituting Meat or Dairy Products with Plant-Based Substitutes Has Small and Heterogeneous Effects on Diet Quality and Nutrient Security: A Simulation Study in French Adults (INCA3). *J. Nutr.* **2021**, *151*, 2435–2445. [CrossRef] [PubMed]
165. Langyan, S.; Yadava, P.; Khan, F.N.; Dar, Z.A.; Singh, R.; Kumar, A. Sustaining Protein Nutrition Through Plant-Based Foods. *Front. Nutr.* **2022**, *8*, 772573. [CrossRef]
166. Spendrup, S.; Hovmalm, H.P. Consumer Attitudes and Beliefs towards Plant-Based Food in Different Degrees of Processing—The Case of Sweden. *Food Qual. Prefer.* **2022**, *102*, 104673. [CrossRef]
167. Jones, P. UK Retailers and Plant-Based Alternatives to Meat and Dairy Products. *Athens J. Bus. Econ.* **2023**, *9*, 207–220. [CrossRef]
168. Cole, E.; Goeler-Slough, N.; Cox, A.; Nolden, A. Examination of the Nutritional Composition of Alternative Beef Burgers Available in the United States. *Int. J. Food Sci. Nutr.* **2022**, *73*, 425–432. [CrossRef]
169. Curtain, F.; Grafenauer, S. Plant-Based Meat Substitutes in the Flexitarian Age: An Audit of Products on Supermarket Shelves. *Nutrients* **2019**, *11*, 2603. [CrossRef]
170. Pointke, M.; Pawelzik, E. Plant-Based Alternative Products: Are They Healthy Alternatives? Micro- and Macronutrients and Nutritional Scoring. *Nutrients* **2022**, *14*, 601. [CrossRef] [PubMed]
171. Romão, B.; Botelho, R.B.A.; Nakano, E.Y.; Raposo, A.; Han, H.; Vega-Muñoz, A.; Ariza-Montes, A.; Zandonadi, R.P. Are Vegan Alternatives to Meat Products Healthy? A Study on Nutrients and Main Ingredients of Products Commercialized in Brazil. *Front. Public Health* **2022**, *10*, 900598. [CrossRef]
172. Tonheim, L.E.; Austad, E.; Torheim, L.E.; Henjum, S. Plant-Based Meat and Dairy Substitutes on the Norwegian Market: Comparing Macronutrient Content in Substitutes with Equivalent Meat and Dairy Products. *J. Nutr. Sci.* **2022**, *11*, e9. [CrossRef] [PubMed]
173. Alexander, P.; Brown, C.; Arneth, A.; Dias, C.; Finnigan, J.; Moran, D.; Rounsevell, M.D.A. Could Consumption of Insects, Cultured Meat or Imitation Meat Reduce Global Agricultural Land Use? *Glob. Food Secur.* **2017**, *15*, 22–32. [CrossRef]

174. Rizzolo-Brime, L.; Orta-Ramirez, A.; Puyol Martin, Y.; Jakszyn, P. Nutritional Assessment of Plant-Based Meat Alternatives: A Comparison of Nutritional Information of Plant-Based Meat Alternatives in Spanish Supermarkets. *Nutrients* **2023**, *15*, 1325. [CrossRef] [PubMed]
175. Koyande, A.K.; Chew, K.W.; Rambabu, K.; Tao, Y.; Chu, D.-T.; Show, P.-L. Microalgae: A Potential Alternative to Health Supplementation for Humans. *Food Sci. Hum. Wellness* **2019**, *8*, 16–24. [CrossRef]
176. Yang, S.; Fan, Y.; Cao, Y.; Wang, Y.; Mou, H.; Sun, H. Technological Readiness of Commercial Microalgae Species for Foods. *Crit. Rev. Food Sci. Nutr.* **2023**, *64*, 7993–8017. [CrossRef] [PubMed]
177. Verni, M.; Demarinis, C.; Rizzello, C.G.; Pontonio, E. Bioprocessing to Preserve and Improve Microalgae Nutritional and Functional Potential: Novel Insight and Perspectives. *Foods* **2023**, *12*, 983. [CrossRef] [PubMed]
178. Wells, M.L.; Potin, P.; Craigie, J.S.; Raven, J.A.; Merchant, S.S.; Helliwell, K.E.; Smith, A.G.; Camire, M.E.; Brawley, S.H. Algae as Nutritional and Functional Food Sources: Revisiting Our Understanding. *J. Appl. Phycol.* **2017**, *29*, 949–982. [CrossRef]
179. Quesada-Salas, M.C.; Delfau-Bonnet, G.; Willig, G.; Préat, N.; Allais, F.; Ioannou, I. Optimization and Comparison of Three Cell Disruption Processes on Lipid Extraction from Microalgae. *Processes* **2021**, *9*, 369. [CrossRef]
180. Akhtar, Y.; Isman, M.B. Insects as an Alternative Protein Source. In *Proteins in Food Processing*; Elsevier: Amsterdam, The Netherlands, 2018; pp. 263–288.
181. Van Huis, A.; Van Itterbeeck, J.; Klunder, H.; Mertens, E.; Halloran, A.; Muir, G.; Vantomme, P. *Edible Insects: Future Prospects for Food and Feed Security*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2013; ISBN 92-5-107596-4.
182. Ndiritu, A.K.; Kinyuru, J.N.; Kenji, G.M.; Gichuhi, P.N. Extraction Technique Influences the Physico-Chemical Characteristics and Functional Properties of Edible Crickets (Acheta Domesticus) Protein Concentrate. *J. Food Meas. Charact.* **2017**, *11*, 2013–2021. [CrossRef]
183. Vandeweyer, D.; Lievens, B.; Van Campenhout, L. Identification of Bacterial Endospores and Targeted Detection of Foodborne Viruses in Industrially Reared Insects for Food. *Nature Food* **2020**, *1*, 511–516. [CrossRef] [PubMed]
184. EFSA Scientific Committee. Risk Profile Related to Production and Consumption of Insects as Food and Feed. *EFSA J.* **2015**, *13*, 4257. [CrossRef]
185. Kouřimská, L.; Adámková, A. Nutritional and Sensory Quality of Edible Insects. *NFS J.* **2016**, *4*, 22–26. [CrossRef]
186. Glover, D.; Sexton, A. Edible Insects and the Future of Food: A Foresight Scenario Exercise on Entomophagy and Global Food Security. 2015. Available online: https://www.researchgate.net/publication/282094473_Edible_Insects_and_the_Future_of_Food_A_Foresight_Scenario_Exercise_on_Entomophagy_and_Global_Food_Security (accessed on 14 July 2024).
187. Orsi, L.; Voege, L.L.; Stranieri, S. Eating Edible Insects as Sustainable Food? Exploring the Determinants of Consumer Acceptance in Germany. *Food Res. Int.* **2019**, *125*, 108573. [CrossRef]
188. Mishyna, M.; Chen, J.; Benjamin, O. Sensory Attributes of Edible Insects and Insect-Based Foods—Future Outlooks for Enhancing Consumer Appeal. *Trends Food Sci. Technol.* **2020**, *95*, 141–148. [CrossRef]
189. Francis, F.; Doyen, V.; Debaugnies, F.; Mazzucchelli, G.; Caparros, R.; Alabi, T.; Blecker, C.; Haubruge, E.; Corazza, F. Limited Cross Reactivity among Arginine Kinase Allergens from Mealworm and Cricket Edible Insects. *Food Chem.* **2019**, *276*, 714–718. [CrossRef]
190. Srinroch, C.; Srisomsap, C.; Chokchaichamnankit, D.; Punyarit, P.; Phiriyangkul, P. Identification of Novel Allergen in Edible Insect, Gryllus Bimaculatus and Its Cross-Reactivity with Macrobrachium Spp. Allergens. *Food Chem.* **2015**, *184*, 160–166. [CrossRef]
191. Mwelwa, S.; Chungu, D.; Tailoka, F.; Beesigamukama, D.; Tanga, C. Biotransfer of Heavy Metals along the Soil-Plant-Edible Insect-Human Food Chain in Africa. *Sci. Total Environ.* **2023**, *881*, 163150. [CrossRef]
192. Fatima, N.; Emambux, M.N.; Olaimat, A.N.; Stratakos, A.C.; Nawaz, A.; Wahyono, A.; Gul, K.; Park, J.; Shahbaz, H.M. Recent Advances in Microalgae, Insects, and Cultured Meat as Sustainable Alternative Protein Sources. *Food Humanit.* **2023**, *1*, 731–741. [CrossRef]
193. Pandurangan, M.; Kim, D.H. A Novel Approach for in Vitro Meat Production. *Appl. Microbiol. Biotechnol.* **2015**, *99*, 5391–5395. [CrossRef]
194. Zuhaib Fayaz Bhat, S.K.; Bhat, H.F. In Vitro Meat: A Future Animal-Free Harvest. *Crit. Rev. Food Sci. Nutr.* **2017**, *57*, 782–789. [CrossRef]
195. Basile, A.; Ferranti, P. Synthetic Meat: Acceptance. In *Reference Module in Food Science*; Elsevier: Amsterdam, The Netherlands, 2019.
196. Garrison, G.L.; Biermacher, J.T.; Brorsen, B.W. How Much Will Large-Scale Production of Cell-Cultured Meat Cost? *J. Agric. Food Res.* **2022**, *10*, 100358. [CrossRef]
197. Ye, Y.; Zhou, J.; Guan, X.; Sun, X. Commercialization of Cultured Meat Products: Current Status, Challenges, and Strategic Prospects. *Future Foods* **2022**, *6*, 100177. [CrossRef]
198. Derbyshire, E.J.; Delange, J. Fungal Protein—What Is It and What Is the Health Evidence? A Systematic Review Focusing on Mycoprotein. *Front. Sustain. Food Syst.* **2021**, *5*, 581682. [CrossRef]
199. Bottin, J.; Swann, J.; Cropp, E.; Chambers, E.; Ford, H.; Ghatei, M.; Frost, G. Mycoprotein Reduces Energy Intake and Postprandial Insulin Release without Altering Glucagon-like Peptide-1 and Peptide Tyrosine-Tyrosine Concentrations in Healthy Overweight and Obese Adults: A Randomised-Controlled Trial. *Br. J. Nutr.* **2016**, *116*, 306–374. [CrossRef] [PubMed]

200. Coelho, M.O.C.; Monteyne, A.J.; Dirks, M.L.; Finnigan, T.J.A.; Stephens, F.B.; Wall, B.T. Daily Mycoprotein Consumption for 1 Week Does Not Affect Insulin Sensitivity or Glycaemic Control but Modulates the Plasma Lipidome in Healthy Adults: A Randomised Controlled Trial. *Br. J. Nutr.* **2021**, *125*, 147–160. [CrossRef]
201. Hashempour-Baltork, F.; Khosravi-Darani, K.; Hosseini, H.; Farshi, P.; Reihani, S.F.S. Mycoproteins as Safe Meat Substitutes. *J. Clean. Prod.* **2020**, *253*, 119958. [CrossRef]
202. Poore, J.; Nemecek, T. Reducing Food's Environmental Impacts through Producers and Consumers. *Science* **2018**, *360*, 987–992. [CrossRef]
203. Smetana, S.; Pernutz, C.; Toepfl, S.; Heinz, V.; Van Campenhout, L. High-Moisture Extrusion with Insect and Soy Protein Concentrates: Cutting Properties of Meat Analogues under Insect Content and Barrel Temperature Variations. *J. Insects Food Feed* **2019**, *5*, 29–34. [CrossRef]
204. Sharma, P.; Kaur, H.; Kehinde, B.A.; Chhikara, N.; Sharma, D.; Panghal, A. Food-Derived Anticancer Peptides: A Review. *Int. J. Pept. Res. Ther.* **2021**, *27*, 55–70. [CrossRef]
205. Coelho, M.O.; Monteyne, A.J.; Dunlop, M.V.; Harris, H.C.; Morrison, D.J.; Stephens, F.B.; Wall, B.T. Mycoprotein as a Possible Alternative Source of Dietary Protein to Support Muscle and Metabolic Health. *Nutr. Rev.* **2020**, *78*, 486–497. [CrossRef]
206. Ahmadi, N.; Khosravi-Darani, K.; Mohammad Mortazavian, A.; Mashayekh, S.M. Effects of Process Variables on Fed-Batch Production of Propionic Acid. *J. Food Process. Preserv.* **2017**, *41*, e12853. [CrossRef]
207. Sharif, M.; Zafar, M.H.; Aqib, A.I.; Saeed, M.; Farag, M.R.; Alagawany, M. Single Cell Protein: Sources, Mechanism of Production, Nutritional Value and Its Uses in Aquaculture Nutrition. *Aquaculture* **2021**, *531*, 735885. [CrossRef]
208. Ahmad, M.I.; Farooq, S.; Alhamoud, Y.; Li, C.; Zhang, H. A Review on Mycoprotein: History, Nutritional Composition, Production Methods, and Health Benefits. *Trends Food Sci. Technol.* **2022**, *121*, 14–29. [CrossRef]
209. Zhang, T.; Dou, W.; Zhang, X.; Zhao, Y.; Zhang, Y.; Jiang, L.; Sui, X. The Development History and Recent Updates on Soy Protein-Based Meat Alternatives. *Trends Food Sci. Technol.* **2021**, *109*, 702–710. [CrossRef]
210. Hocquette, J.-F. Is in Vitro Meat the Solution for the Future? *Meat Sci.* **2016**, *120*, 167–176. [CrossRef] [PubMed]
211. Jin, F.-J.; Hu, S.; Wang, B.-T.; Jin, L. Advances in Genetic Engineering Technology and Its Application in the Industrial Fungus Aspergillus Oryzae. *Front. Microbiol.* **2021**, *12*, 644404. [CrossRef]
212. Santo, R.E.; Kim, B.F.; Goldman, S.E.; Dutkiewicz, J.; Biehl, E.M.B.; Bloem, M.W.; Neff, R.A.; Nachman, K.E. Considering Plant-Based Meat Substitutes and Cell-Based Meats: A Public Health and Food Systems Perspective. *Front. Sustain. Food Syst.* **2020**, *4*, 134. [CrossRef]
213. Faccio, E.; Guiotto Nai Fovino, L. Food Neophobia or Distrust of Novelties? Exploring Consumers' Attitudes toward GMOs, Insects and Cultured Meat. *Appl. Sci.* **2019**, *9*, 4440. [CrossRef]
214. Givens, D.I. Animal Board Invited Review: Dietary Transition from Animal to Plant-Derived Foods: Are There Risks to Health? *Animal* **2024**, *18*, 101263. [CrossRef] [PubMed]
215. Viroli, G.; Kalmpourtzidou, A.; Cena, H. Exploring Benefits and Barriers of Plant-Based Diets: Health, Environmental Impact, Food Accessibility and Acceptability. *Nutrients* **2023**, *15*, 4723. [CrossRef]
216. Pellinen, T.; Päivärinta, E.; Isotalo, J.; Lehtovirta, M.; Itkonen, S.T.; Korkalo, L.; Erkkola, M.; Pajari, A.-M. Replacing Dietary Animal-Source Proteins with Plant-Source Proteins Changes Dietary Intake and Status of Vitamins and Minerals in Healthy Adults: A 12-Week Randomized Controlled Trial. *Eur. J. Nutr.* **2022**, *61*, 1391–1404. [CrossRef] [PubMed]
217. Fairweather-Tait, S. The Role of Meat in Iron Nutrition of Vulnerable Groups of the UK Population. *Front. Anim. Sci.* **2023**, *4*, 1142252. [CrossRef]
218. Nowacka, M.; Trusinska, M.; Chraniuk, P.; Piatkowska, J.; Pakulska, A.; Wisniewska, K.; Wierzbicka, A.; Rybak, K.; Pobiega, K. Plant-Based Fish Analogs—A Review. *Appl. Sci.* **2023**, *13*, 4509. [CrossRef]
219. Macdiarmid, J.I.; Douglas, F.; Campbell, J. Eating like There's No Tomorrow: Public Awareness of the Environmental Impact of Food and Reluctance to Eat Less Meat as Part of a Sustainable Diet. *Appetite* **2016**, *96*, 487–493. [CrossRef]
220. Food and Agriculture Organization. *Sustainable Healthy Diets-Guiding Principles*; FAO: Rome, Italy, 2019.
221. von Koerber, K.; Bader, N.; Leitzmann, C. Wholesome Nutrition: An Example for a Sustainable Diet. *Proc. Nutr. Soc.* **2017**, *76*, 34–41. [CrossRef]
222. Aiking, H.; de Boer, J. The next Protein Transition. *Trends Food Sci. Technol.* **2020**, *105*, 515–522. [CrossRef]
223. Stiftung, H.B. *MEAT ATLAS: Facts and Figures about the Animals We Eat*; Heinrich-Böll-Stiftung: Berlin, Germany, 2014.
224. Drewnowski, A.; Finley, J.; Hess, J.M.; Ingram, J.; Miller, G.; Peters, C. Toward Healthy Diets from Sustainable Food Systems. *Curr. Dev. Nutr.* **2020**, *4*, nzaa083. [CrossRef]
225. Szczebyło, A.; Halicka, E.; Rejman, K.; Kaczorowska, J. Is Eating Less Meat Possible? Exploring the Willingness to Reduce Meat Consumption among Millennials Working in Polish Cities. *Foods* **2022**, *11*, 358. [CrossRef]
226. Paslakis, G.; Richardson, C.; Nöhre, M.; Brähler, E.; Holzapfel, C.; Hilbert, A.; de Zwaan, M. Prevalence and Psychopathology of Vegetarians and Vegans–Results from a Representative Survey in Germany. *Sci. Rep.* **2020**, *10*, 6840. [CrossRef]
227. Hargreaves, S.M.; Raposo, A.; Saraiva, A.; Zandonadi, R.P. Vegetarian Diet: An Overview through the Perspective of Quality of Life Domains. *Int. J. Environ. Res. Public Health* **2021**, *18*, 4067. [CrossRef]
228. Eckl, M.R.; Biesbroek, S.; van't Veer, P.; Geleijnse, J.M. Replacement of Meat with Non-Meat Protein Sources: A Review of the Drivers and Inhibitors in Developed Countries. *Nutrients* **2021**, *13*, 3602. [CrossRef] [PubMed]

229. Chodkowska, K.A.; Wódz, K.; Wojciechowski, J. Sustainable Future Protein Foods: The Challenges and the Future of Cultivated Meat. *Foods* **2022**, *11*, 4008. [CrossRef]
230. Raheem, D.; Carrascosa, C.; Oluwole, O.B.; Nieuwland, M.; Saraiva, A.; Millán, R.; Raposo, A. Traditional Consumption of and Rearing Edible Insects in Africa, Asia and Europe. *Crit. Rev. Food Sci. Nutr.* **2019**, *59*, 2169–2188. [CrossRef] [PubMed]
231. van der Fels-Klerx, H.J.; Camenzuli, L.; Belluco, S.; Meijer, N.; Ricci, A. Food Safety Issues Related to Uses of Insects for Feeds and Foods. *Compr. Rev. Food Sci. Food Saf.* **2018**, *17*, 1172–1183. [CrossRef]
232. Hawkey, K.J.; Lopez-Viso, C.; Brameld, J.M.; Parr, T.; Salter, A.M. Insects: A Potential Source of Protein and Other Nutrients for Feed and Food. *Annu. Rev. Anim. Biosci.* **2021**, *9*, 333–354. [CrossRef] [PubMed]
233. van Huis, A. Prospects of Insects as Food and Feed. *Org. Agric.* **2021**, *11*, 301–308. [CrossRef]
234. Van Huis, A. Insects as Food and Feed, a New Emerging Agricultural Sector: A Review. *J. Insects Food Feed* **2020**, *6*, 27–44. [CrossRef]
235. Rzymski, P.; Kulus, M.; Jankowski, M.; Dompe, C.; Bryl, R.; Petitte, J.N.; Kempisty, B.; Mozdziak, P. COVID-19 Pandemic Is a Call to Search for Alternative Protein Sources as Food and Feed: A Review of Possibilities. *Nutrients* **2021**, *13*, 150. [CrossRef]
236. Homann, A.; Ayieko, M.A.; Konyole, S.; Roos, N. Acceptability of Biscuits Containing 10% Cricket (Acheta Domesticus) Compared to Milk Biscuits among 5-10-Year-Old Kenyan Schoolchildren. *J. Insects Food Feed* **2017**, *3*, 95–103. [CrossRef]
237. Akande, A.O.; Jolayemi, O.S.; Adelugba, V.A.; Akande, S.T. Silkworm Pupae (Bombyx Mori) and Locusts as Alternative Protein Sources for High-Energy Biscuits. *J. Asia-Pac. Entomol.* **2020**, *23*, 234–241. [CrossRef]
238. Biró, B.; Sipos, M.A.; Kovács, A.; Badak-Kerti, K.; Pásztor-Huszár, K.; Gere, A. Cricket-Enriched Oat Biscuit: Technological Analysis and Sensory Evaluation. *Foods* **2020**, *9*, 1561. [CrossRef]
239. Ramírez-Rivera, E.; Hernández-Santos, B.; Juárez-Barrientos, J.; Torruco-Uco, J.; Ramírez-Figueroa, E.; Rodríguez-Miranda, J. Effects of Formulation and Process Conditions on Chemical Composition, Color Parameters, and Acceptability of Extruded Insect-Rich Snack. *J. Food Process. Preserv.* **2021**, *45*, e15499. [CrossRef]
240. Angaman, D.M.; Ehouman, A.G.; Boko, A.C.E. Propriétés Physico-Chimiques, Fonctionnelles et Microbiologiques de La Farine de Maïs Germé Enrichie de Larves d'insectes Comestibles Rhynchophorus Phoenicis et Oryctes Owariensis. *J. Appl. Biosci.* **2021**, *158*, 16310–16320.
241. Machado, C.d.R.; Thys, R.C.S. Cricket Powder (Gryllus Assimilis) as a New Alternative Protein Source for Gluten-Free Breads. *Innov. Food Sci. Emerg. Technol.* **2019**, *56*, 102180. [CrossRef]
242. Bawa, M.; Songsermpong, S.; Kaewtapee, C.; Chanput, W. Nutritional, Sensory, and Texture Quality of Bread and Cookie Enriched with House Cricket (Acheta Domesticus) Powder. *J. Food Process. Preserv.* **2020**, *44*, e14601. [CrossRef]
243. Osimani, A.; Milanović, V.; Cardinali, F.; Roncolini, A.; Garofalo, C.; Clementi, F.; Pasquini, M.; Mozzon, M.; Foligni, R.; Raffaelli, N.; et al. Bread Enriched with Cricket Powder (Acheta Domesticus): A Technological, Microbiological and Nutritional Evaluation. *Innov. Food Sci. Emerg. Technol.* **2018**, *48*, 150–163. [CrossRef]
244. Park, Y.-S.; Choi, Y.-S.; Hwang, K.-E.; Kim, T.-K.; Lee, C.-W.; Shin, D.-M.; Han, S.G. Physicochemical Properties of Meat Batter Added with Edible Silkworm Pupae (Bombyx Mori) and Transglutaminase. *Korean J. Food Sci. Anim. Resour.* **2017**, *37*, 351–359. [CrossRef]
245. Kim, H.-W.; Setyabrata, D.; Lee, Y.J.; Jones, O.G.; Kim, Y.H.B. Pre-Treated Mealworm Larvae and Silkworm Pupae as a Novel Protein Ingredient in Emulsion Sausages. *Innov. Food Sci. Emerg. Technol.* **2016**, *38*, 116–123. [CrossRef]
246. Duda, A.; Adamczak, J.; Chełmińska, P.; Juszkiewicz, J.; Kowalczewski, P. Quality and Nutritional/Textural Properties of Durum Wheat Pasta Enriched with Cricket Powder. *Foods* **2019**, *8*, 46. [CrossRef] [PubMed]
247. Borremans, A.; Bußler, S.; Sagu, S.T.; Rawel, H.; Schlüter, O.K.; Leen, V.C. Effect of Blanching Plus Fermentation on Selected Functional Properties of Mealworm (Tenebrio Molitor) Powders. *Foods* **2020**, *9*, 917. [CrossRef]
248. Purschke, B.; Tanzmeister, H.; Meinlschmidt, P.; Baumgartner, S.; Lauter, K.; Jäger, H. Recovery of Soluble Proteins from Migratory Locust (Locusta Migratoria) and Characterisation of Their Compositional and Techno-Functional Properties. *Food Res. Int.* **2018**, *106*, 271–279. [CrossRef] [PubMed]
249. Stull, V.J.; Kersten, M.; Bergmans, R.S.; Patz, J.A.; Paskewitz, S. Crude Protein, Amino Acid, and Iron Content of Tenebrio Molitor (Coleoptera, Tenebrionidae) Reared on an Agricultural Byproduct from Maize Production: An Exploratory Study. *Ann. Entomol. Soc. Am.* **2019**, *112*, 533–543. [CrossRef]
250. Bawa, M.; Songsermpong, S.; Kaewtapee, C.; Chanput, W. Effect of Diet on the Growth Performance, Feed Conversion, and Nutrient Content of the House Cricket. *J. Insect Sci.* **2020**, *20*, 10. [CrossRef]
251. Mlček, J.; Adámková, A.; Adámek, M.; Borkovcová, M.; Bednářová, M.; Kouřimská, L. Selected Nutritional Values of Field Cricket (Gryllus Assimilis) and Its Possible Use as a Human Food. *Indian J. Tradit. Knowl.* **2018**, *17*, 518–524.
252. Luna, G.C.; Martin-Gonzalez, F.S.; Mauer, L.; Liceaga, A. Cricket (Acheta Domesticus) Protein Hydrolysates' Impact on the Physicochemical, Structural and Sensory Properties of Tortillas and Tortilla Chips. *J. Insects Food Feed* **2021**, *7*, 109–120. [CrossRef]
253. Lucchese-Cheung, T.; de Aguiar, L.K.; Spers, E.E.; De Lima, L.M. The Brazilians' Sensorial Perceptions for Novel Food—Cookies with Insect Protein. *J. Insects Food Feed* **2021**, *7*, 287–299. [CrossRef]
254. Akande, O.A.; Falade, O.O.; Badejo, A.A.; Adekoya, I. Assessment of Mulberry Silkworm Pupae and African Palm Weevil Larvae as Alternative Protein Sources in Snack Fillings. *Heliyon* **2020**, *6*, e03754. [CrossRef]
255. Awobusuyi, T.D.; Pillay, K.; Siwela, M. Consumer Acceptance of Biscuits Supplemented with a Sorghum–Insect Meal. *Nutrients* **2020**, *12*, 895. [CrossRef]

256. Adámek, M.; Adámková, A.; Mlček, J.; Borkovcová, M.; Bednářová, M. Acceptability and Sensory Evaluation of Energy Bars and Protein Bars Enriched with Edible Insect. *Potravin. Slovak J. Food Sci.* **2018**, *12*, 431–437. [CrossRef] [PubMed]
257. Akullo, J.; Agea, J.G.; Obaa, B.B.; Acai, J.O.; Nakimbugwe, D. Process Development, Sensory and Nutritional Evaluation of Honey Spread Enriched with Edible Insects Flour. *Afr. J. Food Sci.* **2017**, *11*, 30–39.
258. Molfetta, M.; Morais, E.G.; Barreira, L.; Bruno, G.L.; Porcelli, F.; Dugat-Bony, E.; Bonnarme, P.; Minervini, F. Protein Sources Alternative to Meat: State of the Art and Involvement of Fermentation. *Foods* **2022**, *11*, 2065. [CrossRef] [PubMed]
259. Raksasat, R.; Lim, J.W.; Kiatkittipong, W.; Kiatkittipong, K.; Ho, Y.C.; Lam, M.K.; Font-Palma, C.; Zaid, H.F.M.; Cheng, C.K. A Review of Organic Waste Enrichment for Inducing Palatability of Black Soldier Fly Larvae: Wastes to Valuable Resources. *Environ. Pollut.* **2020**, *267*, 115488. [CrossRef]
260. Bruno, D.; Bonacci, T.; Reguzzoni, M.; Casartelli, M.; Grimaldi, A.; Tettamanti, G.; Brandmayr, P. An In-Depth Description of Head Morphology and Mouthparts in Larvae of the Black Soldier Fly Hermetia Illucens. *Arthropod Struct. Dev.* **2020**, *58*, 100969. [CrossRef]
261. Castro-López, C.; Santiago-López, L.; Vallejo-Cordoba, B.; González-Córdova, A.F.; Liceaga, A.M.; García, H.S.; Hernández-Mendoza, A. An Insight to Fermented Edible Insects: A Global Perspective and Prospective. *Food Res. Int.* **2020**, *137*, 109750. [CrossRef]
262. Kuttiyatveetil, J.R.A.; Mitra, P.; Goldin, D.; Nickerson, M.T.; Tanaka, T. Recovery of Residual Nutrients from Agri-Food Byproducts Using a Combination of Solid-State Fermentation and Insect Rearing. *Int. J. Food Sci. Technol.* **2019**, *54*, 1130–1140. [CrossRef]
263. Liu, H.; Tan, B.; Kong, X.; Li, J.; Li, G.; He, L.; Bai, M.; Yin, Y. Dietary Insect Powder Protein Sources Improve Protein Utilization by Regulation on Intestinal Amino Acid-Chemosensing System. *Animals* **2020**, *10*, 1590. [CrossRef]
264. Suman, G.; Nupur, M.; Anuradha, S.; Pradeep, B. Single Cell Protein Production: A Review. *Int. J. Curr. Microbiol. Appl. Sci* **2015**, *4*, 251–262.
265. Ercili-Cura, D.; Häkämies, A.; Sinisalo, L.; Vainikka, P.; Pitkänen, J.-P. Food out of Thin Air. *Food Sci. Technol.* **2020**, *34*, 44–48. [CrossRef]
266. Ritala, A.; Häkkinen, S.T.; Toivari, M.; Wiebe, M.G. Single Cell Protein—State-of-the-Art, Industrial Landscape and Patents 2001–2016. *Front. Microbiol.* **2017**, *8*, 2009. [CrossRef]
267. Bratosin, B.C.; Darjan, S.; Vodnar, D.C. Single Cell Protein: A Potential Substitute in Human and Animal Nutrition. *Sustainability* **2021**, *13*, 9284. [CrossRef]
268. Leger, D.; Matassa, S.; Noor, E.; Shepon, A.; Milo, R.; Bar-Even, A. Photovoltaic-Driven Microbial Protein Production Can Use Land and Sunlight More Efficiently than Conventional Crops. *Proc. Natl. Acad. Sci. USA* **2021**, *118*, e2015025118. [CrossRef]
269. Matassa, S.; Boon, N.; Pikaar, I.; Verstraete, W. Microbial Protein: Future Sustainable Food Supply Route with Low Environmental Footprint. *Microb. Biotechnol.* **2016**, *9*, 568–575. [CrossRef] [PubMed]
270. Linder, T. Making the Case for Edible Microorganisms as an Integral Part of a More Sustainable and Resilient Food Production System. *Food Secur.* **2019**, *11*, 265–278. [CrossRef]
271. Ciani, M.; Lippolis, A.; Fava, F.; Rodolfi, L.; Niccolai, A.; Tredici, M.R. Microbes: Food for the Future. *Foods* **2021**, *10*, 971. [CrossRef]
272. Sillman, J.; Nygren, L.; Kahiluoto, H.; Ruuskanen, V.; Tamminen, A.; Bajamundi, C.; Nappa, M.; Wuokko, M.; Lindh, T.; Vainikka, P.; et al. Bacterial Protein for Food and Feed Generated via Renewable Energy and Direct Air Capture of CO_2: Can It Reduce Land and Water Use? *Glob. Food Secur.* **2019**, *22*, 25–32. [CrossRef]
273. Somda, M.K.; Nikiema, M.; Keita, I.; Mogmenga, I.; Kouhounde, S.H.; Dabire, Y.; Coulibaly, W.H.; Taale, E.; Traore, A.S. Production of Single Cell Protein (SCP) and Essentials Amino Acids from Candida Utilis FMJ12 by Solid State Fermentation Using Mango Waste Supplemented with Nitrogen Sources. *Afr. J. Biotechnol.* **2018**, *17*, 716–723.
274. Bamforth, C.W.; Cook, D.J. *Food, Fermentation, and Micro-Organisms*; John Wiley & Sons: Hoboken, NJ, USA, 2019; ISBN 1-4051-9872-9.
275. Barzee, T.J.; Cao, L.; Pan, Z.; Zhang, R. Fungi for Future Foods. *J. Future Foods* **2021**, *1*, 25–37. [CrossRef]
276. Jach, M.E.; Serefko, A. Chapter 9—Nutritional Yeast Biomass: Characterization and Application. In *Diet, Microbiome and Health*; Holban, A.M., Grumezescu, A.M., Eds.; Handbook of Food Bioengineering; Academic Press: Cambridge, MA, USA, 2018; pp. 237–270. ISBN 978-0-12-811440-7.
277. Jach, M.E.; Serefko, A.; Ziaja, M.; Kieliszek, M. Yeast Protein as an Easily Accessible Food Source. *Metabolites* **2022**, *12*, 63. [CrossRef]
278. Hashempour-Baltork, F.; Hosseini, S.M.; Assarehzadegan, M.-A.; Khosravi-Darani, K.; Hosseini, H. Safety Assays and Nutritional Values of Mycoprotein Produced by Fusarium Venenatum IR372C from Date Waste as Substrate. *J. Sci. Food Agric.* **2020**, *100*, 4433–4441. [CrossRef] [PubMed]
279. Irazusta-Garmendia, A.; Orpí, E.; Bach-Faig, A.; González Svatetz, C.A. Food Sustainability Knowledge, Attitudes, and Dietary Habits among Students and Professionals of the Health Sciences. *Nutrients* **2023**, *15*, 2064. [CrossRef]
280. Milanesi, M.; Guercini, S.; Runfola, A. Let's Play! Gamification as a Marketing Tool to Deliver a Digital Luxury Experience. *Electron. Commer. Res.* **2023**, *23*, 2135–2152. [CrossRef]
281. Huang, M.; Mohamad Saleh, M.S.; Zolkepli, I.A. The Moderating Effect of Green Advertising on the Relationship between Gamification and Sustainable Consumption Behavior: A Case Study of the Ant Forest Social Media App. *Sustainability* **2023**, *15*, 2883. [CrossRef]

282. Grangeia, T.d.A.G.; De Jorge, B.; Cecílio-Fernandes, D.; Tio, R.A.; de Carvalho-Filho, M.A. Learn+ Fun! Social Media and Gamification Sum up to Foster a Community of Practice during an Emergency Medicine Rotation. *Health Prof. Educ.* **2019**, *5*, 321–335. [CrossRef]
283. Bogusz, M.; Matysik-Pejas, R.; Krasnodębski, A.; Dziekański, P. Sustainable Consumption of Households According to the Zero Waste Concept. *Energies* **2023**, *16*, 6516. [CrossRef]
284. Nekmahmud, M.; Ramkissoon, H.; Fekete-Farkas, M. Green Purchase and Sustainable Consumption: A Comparative Study between European and Non-European Tourists. *Tour. Manag. Perspect.* **2022**, *43*, 100980. [CrossRef]