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Market Trends and Challenges for Fermented Protein and Insect Protein in Alternative Proteins

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Abstract:

With the advancement of society and the development of technology, the population has also continued to increase. Consequently, humanity's demand for protein has also been steadily increasing. Traditional methods of getting protein have begun to show some disadvantages in terms of environment and the utilization of energy efficiency. Such as low energy conversion efficiency because of poor feed conversion rates, and the production of large quantities of carbon dioxide exacerbating the greenhouse effect. As a result, people are increasingly turning their attention to other greener and more environment-friendly avenues to obtain proteins. Among these methods, alternative proteins, as an emerging technology, have received widespread attention for their application in producing artificial meat through techniques such as high-moisture extrusion and 3D printing. This project has significant market potential and value. This essay analyses future market trends and challenges associated with synthetic artificial meat produced by using alternative proteins, examining both consumers and technological aspects. The aim is to provide reference for in-depth research and application within the alternative protein sector.

Keywords: Alternative proteins; fermented protein; insect protein; market consumption; sustainable development.

1. Introduction

In recent years, with the population growing, so the demand for protein has risen, resulting in a number of problems with traditional protein sources, such as extreme weather, global warming, and animal welfare and ethical problems. As early as 2015, the United Nations launched 17 Sustainable Development Goals, aiming to achieve sustainable development by around 2050. According to research by Wood et al., greenhouse gas produced by the current food supply chain accounts for as much as 26% of total human-generated greenhouse gases [1]. Another study by Poore et al. further pointed out that it would pro-

duce negative impacts detrimental to sustainable development, such as environmental acidification [2]. As a result, people are increasingly paying more and more attention to emerging methods of protein obtaining. With the research progressing, alternative protein technology has begun to enter the people's field of vision. This technology combines elements from many fields such as cell engineering, food science, and cell culture, and this technology may become one of the important methods for obtaining protein in the future. Alternative protein technologies have made excellent progress over recent years, a 2023 investigation showed that approximately 1,795 patents out of 3,599 in the artificial meat sector were researched and applied for during the ten-year period from 2014 to 2023 [3]. This phenomenon reflects the rapid development trend of this technology. However, alternative proteins still face serious challenges. For example, the technology for producing cell-cultured meat requires the use of animal-derived serum, which undoubtedly increases costs while also creating conflicts with respect to animal welfare and ethical issues. Additionally, artificial meat produced using alternative proteins also faces a number of challenges, including low market acceptance and supply constraints and so on. Moreover, while plant-based meat and cell-cultured meat technologies are more mature, other representative alternative proteins such as fermented proteins (especially fungal proteins) and insect proteins have not been systematically reviewed and analyzed. Therefore, this paper will focus on the market analysis of fermented protein and insect protein, describing the market opportunities and challenges faced by these two alternative protein sources, in order to provide excellent development directions for these two protein types.

2. Overview of Two Types of Protein

2.1 Fermented Protein

Using microorganisms that are good at producing proteins for fermentation, and through methods such as genetic engineering to make them produce specific target molecules, which are finally separated and purified, it also has the advantages of being relatively efficient and clean. Research by some scholars has revealed that readily available and renewable carbon dioxide feedstock and its energy-rich compounds can serve as perfect raw materials for microbial protein production [4]. At the same time, fermented proteins require lower environmental conditions for growth and cultivate at a relatively faster rate than plants. Under the optimal environmental conditions simulated in the fermenter, microbial fermentation can be performed continuously for 24 hours. In fungal fermentation, some fungi act as the decomposer, requiring only the growth environment of decaying wood, fallen leaves, and other humus. The spores used for cultivation are large in number, while the mature fungi are relatively small in size. Under suitable conditions, they can grow rapidly, enabling the cultivation of relatively large quantities of fungal protein within a short timeframe. At the same time, fermented protein is different from cell-cultured meat in that it does not require various complex reagents to guide its division and differentiation, which also reduces costs to a certain extent.

2.2 Insect Protein

Humans have a long history of consuming insects, and these creatures are naturally highly valued as a nutrient-rich food source. For example, crickets contain as much as 60% protein and are also rich in omega-3 fatty acids, vitamins, minerals and other nutrients. The major method currently employed to obtain insect protein is by establishing insect farms, which means simulating the growth environment required for insects within specific containers and rearing a single type of insect. In terms of cost, insect protein also has significant advantages. For example, insect farms require less land area and achieve higher feed conversion efficiency compared to traditional animal husbandry. Moreover, insect farms are also considered a viable option for processing kitchen waste and addressing food waste.

3. Market Research

Following an inquiry into the market distribution of all mainstream categories of alternative proteins, it was discovered that the largest market of alternative proteins is currently North America, followed by Europe, then the Asia-Pacific region, the Middle East and Africa, and South America, and other regions [5]. This may be because the market for alternative protein projects has been promoted and experimented with primarily by the developed countries, while developing nations have less understanding of the project and face higher technological costs. However, this does not prevent alternative proteins from having significant market potential and value. Based on the previous market research's prediction, both fermented proteins and insect proteins are expected to achieve excellent annual market growth rates by 2026. The rate of fermented proteins is projected to be 5%, with a market value reaching US$422.26 million; while insect proteins could even reach 45.7%, with a market value reaching US$1.33 billion, and may even reach US$8 billion in 2030 [5]. The current primary target audience of alternative proteins is flexible vegetarians, who constitute one-third of all consumers.

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This primary target comprises young people with higher education and those who eat meat infrequently, among which women hold a major place. From the type of alternative protein perspective, plant-based proteins enjoy the highest level of acceptability, cultured meat and fermented proteins are accepted moderately, while insect-based proteins are the lowest in terms of acceptability [6]. Because of culture and consumer attitudes, insects —whether larvae or adults—are considered unhygienic and associated with negative food sensations. This results in insect protein possibly being at a disadvantage in the marketplace. In most cultures, eating insects or finding them in food is considered unhygienic and disgusting, which may be one reason for the low acceptance of insect protein. However, in certain regions where insect consumption is part of the food culture—such as Yunnan in China or Korea— the acceptability of insect protein may be higher compared to areas where insects are not consumed.

The acceptance of alternative proteins by consumers is equally very important. Currently, the price of alternative protein products is commonly higher than that of traditional meat, which has become one of the major obstacles to consumers who will try to accept them. Moreover, the sensory characteristics of the product—including color, texture and flavor—directly influence its market permeability. Consumers prefer alternative protein products that are lower in price than real meat, while also being closer in color, texture and flavor to real meat. According to the research findings, there are also significant differences in the acceptability of alternative proteins among various countries in the world: the acceptability is relatively lower in some countries such as the United Kingdom and Brazil, while consumers in countries like China, the United States, Germany, and India are more willing to try these products [7]. Moreover, many consumers may only overcome their food neophobia: that means consumers are unwilling to try new foods, to avoid potential discomfort. Consumers‘ willingness to continue purchasing alternative protein products may still have significant space for improvement. At the same time, the transparency of ingredients and the accuracy of nutritional labelling of alternative protein products are also important factors in consumer decision-making. That means consumers require detailed information about the sources of ingredients and the nutritional value of these products.

4. Opportunities and Challenges

4.1 The Rise of Vegetarianism

In recent years, vegetarianism has gradually become increasingly popular, and some consumers choose to reduce their meat intake for animal welfare or environmental protection reasons. However, a single vegetarian diet may not fully meet the human body‘s full requirements for all amino acids and some trace elements. The advent of alternative proteins offers an effective solution to this problem. In fact, the growing number of flexitarians and consumers who are willing to purchase alternative protein products has resulted in a market growth trend of alternative proteins. Flexitarians have accounted for 10% to 69% of the total consumer population in some countries [8].

4.2 The Influence of Some Religion and Food Culture

There are significant differences in consumers‘ preferences of food texture and flavor in different regions. This is caused by various factors, such as cultural differences, geographical environment, and the influence of religious culture. In addition, some researchers have also found that even though current dietary characteristics tend to be similar, such as high sugar and high fat content, there are still distinct regional preferences in taste [9]. This may be a possible direction for developing alternative protein products. By researching regional taste preferences, researchers can add different flavoring agents during cultivation or production processes, and in turn develop alternative protein products which are more popular in the local market.

4.3 The Relevant Technology Still Requires Development and Refinement

Fermented proteins, including fungal proteins, have excellent development potential, but the most important factor to consider at present is still the selection of microbial strains. The nutritional value of different types of microbial communities is different, and the flavor compounds and textural fibers that they contain are also significantly varied. Therefore, the difficulty of using different types of microorganisms or microbial communities to produce alternative protein products is also different. Focusing on enriching microbial community species, screening and cultivating microorganisms which are rich in appropriate nutrients or possess a texture similar to real meat fibers may further improve the quality of fermented protein.

Fungal proteins possess a relatively high protein content, though their production of some trace elements or vitamins may be poor, and they have a risk of causing gout [10]. Also at present, the processing techniques employed for fungal protein are similar to those used in plant protein, that is the use of high-moisture extrusion, electrospinning and other technologies. During processing, nutrient wastage may happen because of the temperature variations involved. Therefore, future research could focus

on employing 3D printing or developing more gentle techniques and seek more thorough methods for separating nucleic acids during processing and establishing scaled-up production and processing techniques.

Although insects possess high nutritional value and favorable feed conversion efficiency, the cost of feeding at insect farms is still a significant issue. Moreover, feeding insects requires the purchase of specialized rearing equipment and cleaning equipment, while physical factors such as humidity, temperature and light must be strictly controlled to simulate the environment required by the insects [11]. As a relatively enclosed environment, insect farms require stringent environmental controls to prevent disturbance from adverse factors such as fungi, bacteria, parasites and viruses, which may cause significant losses if the farm is not properly managed. And some species of insects themselves exhibit cannibalistic characteristics, which may lead to unnecessary losses in costs during the farming process. The current insect protein market is affected by consumer perceptions and cultural factors, resulting in relatively low market prices with limited profit spaces. The development of insect protein requires not only more automated, scaled-up, intelligent equipment and management systems, but also the transformation of consumers‘ attitudes.

Moreover, like common allergens such as peanuts, soybeans, milk, and eggs, fermented proteins and insect proteins possess a certain degree of allergenicity. This may lead to allergic symptoms including urticaria, vomiting, and diarrhea. At the same time, due to potential complexities in their cultivation process—such as feeding insects with kitchen waste or using beef extract or peptones rich in flavor compounds to cultivate fermented proteins with specific flavors —this may result in a wider range of allergenic potential. Similar to silkworm manure fish farming in mulberry in fishponds, which uses silkworm larvae‘s excrement as the fish feed. Chicken manure farming is equally possible within insect farms; although it does enhance energy utilization efficiency, it equally increases the risk of contamination. Therefore, before fermented proteins and insect proteins are used as food, these should be clearly subjected to a strict pathological and toxicological analysis, and their allergens, feed ingredients and sources should be clearly labelled.

5. Conclusion

As the world‘s population continues to increase, the traditional food chain has exerted a significant impact on the environment. Alternative proteins have garnered considerable attention because of their high energy utilization efficiency, superior feed conversion rates, and reduced land requirements. They have excellent market value and potential. The application of alternative proteins is now beginning to mature within the food sector and expand into various fields, moving beyond a single focus on artificial meat. For example, as fermented proteins are produced by programming and cultivating microorganisms to generate specific functional components, it is possible to produce collagen for medical and cosmetic areas, or whey protein commonly found in protein powder production. Meanwhile, fermented proteins have some advantages in producing specific flavor compounds that may be used to develop alternative protein products tailored to regional taste preferences in the future. Insect protein is currently widely utilized in the food industry, grinding into high-protein meals and adding to foods to enhance their protein content. Furthermore, owing to its comprehensive nutritional benefits and the absence of acceptance issues in the pet sector, it holds considerable development potential within the pet food market.

Although alternative proteins hold excellent market potential, there are still significant areas for advancement in the development of fermented proteins and insect proteins within this sector. On the one hand, from a technical perspective, it is necessary to overcome nutrient loss, select higher-quality microbial communities and insect varieties, enhance the sensory qualities of the product, and reduce costs. On the other hand, in the market side, there is a need to strengthen consumer education, disseminate knowledge about alternative proteins, guide consumers to overcome food neophobia and encourage them to try alternative protein products, and enhance product competitiveness to create greater profit margins. Concurrently, there is a need to improve relevant policies by establishing robust regulations on naming, labelling, nutritional standards, and market access for alternative protein products, ensuring their safety and traceability. This safeguards consumers‘ rights regarding alternative proteins. Alternative proteins, as an innovative and environmentally friendly source of protein obtained, will drive the global food supply towards sustainability through advancements in food technology and the refinement of market policies.

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