

Risk Assessment of Meat Prepared Dishes and Reflections on Food Safety

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Abstract. With the rise of the house economy and the accelerated pace of people's lives, the public's consumption concept is also changing. Traditional dishes have been unable to meet people's requirements for high quality of life, and prepared dishes have emerged. Meat-prepared food is an important part of prepared dishes and although it is now facing a high market demand, there are still problems related to chemical safety and standards that need to be revolutionized in terms of its processing transportation, and storage. And again under the influence of the epidemic, the processing characteristics and nutritional value of meat-prepared dishes have attracted much attention, so the assessment of their safety riskiness is particularly important. This study addresses the issue of safety risks of meat prepared dishes, provides an in-depth understanding of the development status of the prepared dish industry in China, analyzes and evaluates its risks, and makes appropriate interventions and measures to cope with food safety issues, providing theoretical references for the development of meat prepared dishes.

Keywords: Prepared meat dishes; Status quo; Chemical safety control strategies; Microbiological risks; Risk assessment.

1. Introduction

With the accelerated pace of modern life, people's consumption habits are also evolving rapidly. A quick, convenient and nutritionally balanced diet has become the ultimate goal for many people. Traditional dishes and simple convenience food no longer satisfy people's desire for a quality lifestyle. This has led to the rise of prepared meat dishes [1]. These dishes, often made from fresh or frozen meat and poultry, undergo a series of complicated processes to transform them into convenient and delicious meals that can be enjoyed at any time.

The rise of "home economics" has boosted consumer demand for meat-prepared dishes. The study can help enterprises better adapt to market changes, but also provide a reference basis for the standardized development of the industry [2]. In addition, various local governments have taken policies to promote the meat-prepared dish industry and gradually set up relative industrial parks. Therefore, the investigation of meat-prepared products can not only promote product innovation and improve consumers' eating experience, but also ensure food safety and hygiene, which is of great significance to the standardization and high-quality development of the entire preparation industry.

Currently, consumer demand for meat and poultry dishes in China will gradually increase. Consumers' expectations for convenience food include strengthening control of food hygiene and safety, improving product cost efficiency, improving the taste of product reconstruction, etc. The gradual improvement of cold chain logistics technology has given the preparation industry the ability to ensure the quality of food service ingredients during transportation and storage and meet consumer demands for high-quality taste. However, the prepared dishes industry faces risks and challenges, such as the lack of uniformity in national and industry-wide standards, the difficulty of guaranteeing quality, and the C-end market to be developed [3].

In this paper, the multi-case study method is applied, using the meat-prepared dish as a single research object. The aim is to explore the development status and evolution of the market to analyze the current risks and chemical safety, and propose coping strategies and prospects, so as to provide a

reference for ideas to optimize the food security of ready-to-eat food, which has broad market and research value.

2. History, Current Situation and Risk

Prepared food first originated in the United States in the early 20th century. At that time, with the acceleration of industrialization, people began to pursue a more efficient way of cooking to adapt to the fast-paced life [4]. In the 1970s, prepared food in Japan experienced a period of rapid development, maintaining an annual growth rate of about 20%. During this period, large-scale prepared food companies such as Kobe Bussan and Nippon Cold Group were born, focusing on the development of frozen prepared food and logistics. Japan's prepared food industry has benefited from the support of factors such as increased female labor force participation in the workforce, an aging society, and the rise of convenience stores. Looking back at China's history, as early as 2,000 years ago in ancient China, people began to consume foods similar to today's prepared dishes. These foods were made primarily for easy storage and portability. Over time, the preparation of prepared dishes has improved and become more varied, becoming part of the Chinese food culture. Entering the 21st century, China's prepared food industry began to grow rapidly, especially in the B-side market. By 2020, the C-suite demand has surged due to the Shinkan Epidemic, and traditional prepared food companies have been laying claim to the C-suite market.

In 2020, the market for offline catering shrank by 15.4% due to the new crown pneumonia epidemic, and total consumption fell sharply to 4 trillion dollars. Even now that the virus is less virulent and the epidemic has been liberalized, the market size of the catering industry is still declining. And according to the monitoring report for 2022-2023, the market size of China's meat and poultry preparations amounted to 97.7 billion yuan in 2021, a year-on-year growth of 17.8%, and it is expected that the meat preparations market will continue to maintain a high growth rate in the future, so the prepared meal market still has a lot of room for expansion.

The epidemic has not only changed the way people work, but also the way people live. Demand in the prepared meals market continues to grow and the industry still has plenty of room for development, while offline catering is restricted. The blow dealt to the restaurant industry by the global epidemic is undoubtedly huge, and in the post-epidemic period, the question is how the restaurant industry can seize the critical period of self-transformation and actively transform itself is the key to survival and development.

There are various risks in the prepared food industry, including food safety issues, the risk that consumption habits changes and expectations are not met, the risk that market penetration in the domestic market does not meet expectations, the risk of product promotion, the risk of uncertainty in the fluctuation of raw material prices for prepared foods, etc. Another important risk factor is that companies fail to meet expectations in terms of their operational capabilities[5].

2.1. Safety Risks of Processed Food

The food safety risk in the processing and operation of prepared foods is associated with a variety of food safety problems, which hinder the healthy and sound development of the prepared food industry [6]. First, the selection of raw materials for prepared food: Many prepared food manufacturers do not pay attention to the quality of raw materials and food safety control in the selection of raw materials for prepared food, and use inferior or inferior ingredients to save costs, resulting in some raw materials from unreliable sources entering the prepared food field. Secondly, some manufacturers do not pay attention to hygiene and safety when processing ready meals, the equipment is not up to standard, there are non-compliant processes, such as the lack of separation of raw and cooked foods, the lack of strict standardized quality and safety tests, the processing process is not transparent, the packaging materials are not safe, and the infection link is redundant, from the environmental conditions during production and processing, to the operating technology during processing, to the packaging of products after processing, every link is prone to food safety risks that

need to be overcome in the processing of ready meals. Thirdly, the risk of excessive use of additives or the use of illegal additives is particularly high. Data on food safety issues related to prepared foods in 2023 showed that 68.55% of consumers were concerned about the use of illegal additives [7].

2.2. Microbiological Safety Risks in Transportation and Storage

Microorganisms in meat products produce a large number of amines, ketones, aldehydes, indoles, organic acids, etc. during the growth and reproduction process, which leads to discoloration of meat products, off-flavours and the formation of slime [8]. In addition, oxidation of meat products is one of the main factors affecting meat quality, including lipid oxidation and protein oxidation. Lipid oxidation produces volatile oxidation products such as aldehydes and ketones and harmful substances. During transportation or storage, food is prone to breakage, deformation and so on. Not only that, the rich nutrients in meat prepared dishes are prone to oxidative damage or contamination by microorganisms, which may result in the loss of nutrients, odor, discoloration, etc., affecting the quality and safety of food, and generating ingredients (such as nitrosamines and heterocyclic amines) that are hazardous to human health [9]. Meat prepared dishes in the cold chain transportation, low-temperature refrigeration process is very likely to have manual errors, manual backward transportation caused by cross-contamination and other risks, and how to properly handle and store the prepared dishes after consumers get them is also a potential risk [1].

3. Assessment of the risks

3.1. Process Risk Assessment

A number of carcinogenic or mutagenic compounds, e.g. nitrosamines, aflatoxins, benzo(a)pyrene, etc., can be produced and present in processed meat. The International Agency for Research on Cancer (IARC) classifies these as "Group I carcinogens for humans". All three substances were classified as Class 1 carcinogens by the World Health Organization in 2012.

It is known that nitrite is a good preservative for meat products, they can give meat products an attractive color, but they also pose risks to human health. Nitrite enters the body and the proteolytic substances in the stomach combine to form carcinogenic nitrosamines, which are highly carcinogenic. It may also cause tumors in offspring via the placenta and has teratogenic and mutagenic effects. It is mainly found in canned food, processed meat products and night foods.

Aflatoxin is the strongest biocarcinogen and has a destructive effect on liver tissue. It is mainly found in moldy peanuts and corn as well as in spoiled rice.

Benzo(a)pyrene is a kind of pentacyclic aromatic hydrocarbon. Long-term consumption of food containing high level of benzo(a)pyrene is easy to induce lung cancer and gastrointestinal tumors. It mainly comes from high-temperature fried foods, barbecued foods, and vehicle exhaust.

Various links in the production process should be set up with key control points, preventive measures, and fewer mistakes in each link, so as to ensure the final quality of the product, which improves the production efficiency to some extent. And the factory should strictly control the ratio of various oil and salt contents, control the addition of additives, and carry out targeted research and development for the characteristics and production methods of different foods [4].

3.2. Microbiological Assessment

Meat prepared dishes are highly susceptible to infection by foodborne pathogens, and in the study of foodborne diseases in China in recent years, researchers have found that foodborne diseases caused by microorganisms and parasites account for a relatively large proportion of foodborne diseases. The most common foodborne pathogens in meat prepared dishes include *Escherichia coli*, *Staphylococcus aureus*, *Salmonella* and *Vibrio parahaemolyticus*, and the most common parasites include *Toxoplasma gondii* and *Trichinella* [1]. The types of common foodborne pathogens found in meat

dishes and their respective safety ratings: First class, (E.coli) ≤ 100 ; Second class, (Staph.aureus) ≤ 100 ; Third class, (Salmonella) ≤ 10 ; Fourth class, (Vibrio parahaemolyticus) ≤ 10 [10].

4. Intervention

Studies have shown that the challenge of controlling the chemical safety of meat preparations requires the use of antioxidants and strategies to inhibit the production of contaminants to ensure the safety of the product. Meat preparations have certain safety risks in the production and processing process, such as pesticide and veterinary drug residues and illegally added substances, which have a serious impact on food quality and safety [11]. In order to protect the health and safety of consumers, it is necessary to strengthen the chemical safety control of meat dishes.

First, enterprises should form a complete and continuous production norms, strengthen the understanding of the key points of production, and the higher supervisory departments should also pay attention to the factory's pre-supervision, to avoid the supervision of irregularities leading to a series of subsequent food safety problems. Secondly, talent is an important condition to promote the realization of high-quality development of the prepared food industry, production enterprises should introduce more prepared food theoretical knowledge and skills of the composite talents to strengthen personnel training, so as to further overcome the technical difficulties of research and development, and improve production efficiency and product quality. Third, scientific packaging can prevent the corruption and deterioration of dishes. The packaging of prepared dishes should be designed according to the characteristics of the dishes. For example, for fresh dishes, calcium oxide can be added to the desiccant to absorb the water produced by its respiration and delay the deterioration of the product. It is also possible to introduce an intelligent packaging technology that automatically adjusts temperature and humidity to preserve freshness according to changes in the surrounding environment. In addition, green packaging is also essential, can be widely used biodegradable packaging to protect the environment [4,12,13].

4.1. Antioxidant Application of Chestnut Extract in Meat Products

The use of chestnut extract as a natural source for the production of antioxidant compounds, especially polyphenols and VE, has been evaluated and optimized in several studies and can be a good substitute for artificial antioxidants such as butylated hydroxyanisole, di-tert-butyl-p-cresol, etc., which have several potential applications in the food sector, such as improving the nutritional and qualitative properties of meat and delaying its oxidation process. In addition, it has been found that the use of chestnut extracts can improve the quality of meat and prolong the shelf life. Chestnut extracts contain a large number of antioxidants such as polyphenols and flavonoids, which can protect meat products well, but the antioxidant effect of extracts from different tissues is different. (As shown in Table 1).

Table 1. Chestnut extracts as natural antioxidants in meat products [14].

Products	Storage conditions	Extracts	Additive quantity	Results
Scrambled Eggs with Sausage as a Prepared Dish	Maturity, 45d	Chestnut Extract	1g/kg	Lower mold and yeast counts, no difference in pH, higher hardness, higher moisture content.
Stir-fried Pork with Chili Peppers in Prepared food	Modified atmosphere, 2°C, 20d	Chestnut Extract	1g/kg	There was no significant change in the total number of colonies, no difference in pH, and the highest oxidation of fats and oils.
Stir-fried Beef with Prepared food	Air-conditioned freshness, (2±1)°C, conventional light 18d	Chestnut Extract	500mg/kg	There was no significant change in the total number of colonies, no difference in DH values, and chestnut leaf extract was the most effective in inhibiting lipid oxidation

4.2. Inhibition of Harmful Bacteria in Meat Products from Processed Food

Meat products are susceptible to bacterial contamination during processing and storage, which can affect the quality and safety of meat products during consumption [15]. Lactobacilli have been shown in many experiments to be a natural and efficient strain to fight pathogens in food, as they contain organic acids and bacteriocins. Lactobacilli can be used as excellent biological inhibitors for food safety. When Lactobacillus is added to meat products, the acidic substances and antimicrobial peptides produced by its metabolism can inhibit the growth of spoilage and pathogenic bacteria and improve the organoleptic properties of meat products while acting as a preservative. Lactobacillus plantarum CMRC6 and Lactobacillus sakeus CMRC15 can promote the nitrosation reaction of myoglobin, resulting in the typical pink color of salami; Lactobacillus may also partially or completely replace nitrite in meat [16,17]. Therefore, as a biological bacteriostatic agent for meat and meat products, lactic acid bacteria can improve the color, nutritional structure and sensory properties of meat to a certain extent, while reducing the acidity and alkalinity of meat, effectively controlling spoilage bacteria and pathogenic bacteria in food, and ensuring the quality and safety of food.

5. Limitation

Safety issues such as the presence of foodborne pathogens and parasites in meat ingredients remain a potential risk to human health. The development of a scientific source control system to control good hygiene in livestock farming is still not well developed. There are still problems in the production factories, such as unstrict control of processing, production environment and hygiene. Not only that, meat prepared dishes in the process of transportation and storage, there may be a variety of microorganisms, although now the high demand for meat prepared dishes, there are still backward technology research and development, the lack of composite talents, the enterprise on the quality control of the product is not perfect and other issues. In the view of senior food practitioners, people usually think that prepared dishes are unhealthy, and most of the pre-prepared dishes on the market are heavy oil and salt, and even the ingredients are not fresh, so If this bad phenomenon is to change, it will require a change in the entire industry.

6. Conclusion

With the rise of the house economy and the accelerated pace of life, the concept of people's consumption has also changed. Meat prepared dishes have been accepted by more and more people because of their convenience, and with the gradual improvement of supply chain, prepared dishes have become mainstream. This paper provides an in-depth analysis of the meat-prepared dish industry from four perspectives: history, current state of research, risk assessment, interventions and limitations.

As for the current situation and development trend of the industry, there are problems in the prepared food industry such as the lack of uniformity of national and industry-wide standards, the difficulty of ensuring quality, and the C-end market to be developed. At the same time, the improvement of cold chain logistics technology brings development opportunities for the ready-to-eat food industry to meet consumers' demands for taste and experience quality.

In terms of risk assessment, the prepared food industry faces food safety risks, the risk of changing consumption habits and failing to meet expectations, lower than expected domestic market penetration rate, product promotion risks and the uncertainty risk of fluctuating raw material prices for prepared food. As for the microbiological risk of meat products and the safety risk of processed food, the industry needs to strengthen the control of raw material quality and food safety, strictly regulate quality and safety testing, improve the transparency of the processing process and ensure the safety of product packaging.

In terms of interventions, enterprises should set key points, strengthen the supervision of the production process, and introduce complex talents to improve production technology and solve R&D problems. For the product can also use intelligent packaging technology to improve the active ingredients and better ensure product quality. Moreover, the industry needs to adopt antioxidants and strategies to inhibit the production of harmful substances to ensure product safety. For example, the use of chestnut extract as a natural antioxidant can improve the nutritional and quality characteristics of meat and slow down its oxidation process. In addition, lactic acid bacteria, as a natural and efficient bioinhibitor, can inhibit the growth of spoilage and pathogenic bacteria in meat products and improve their sensory characteristics while ensuring food safety.

To summarize, the development of the prepared food industry in China is promising, but there are a number of risks and challenges to overcome. By strengthening food safety risk control, improving product quality and safety, and actively developing the C-suite market, the prepared food industry is expected to achieve sustainable development and meet consumer demand for convenient, tasty and safe food.

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