ISSN 2616-5902 Vol. 6, Issue 1: 278-283, DOI: 10.25236/AJBM.2024.060140

Research on Quality Control of Fresh Food Supply Chain

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Abstract: *The quality and safety issues of fresh food have recently attracted increasing attention. At the current stage, there are still many challenges in the quality control of the fresh food supply chain, leading to frequent quality problems during the actual supply process, and the improvement of the quality of fresh food has reached a bottleneck. This paper analyses the quality control problems existing in the supply chain of fresh food in China: long supply chain, many circulation links; The technical level of fresh cold chain is backward, and the ratio of product preservation; Farmers are in a weak position, easy to produce "shoddy" moral hazard; The relationship of fresh supply chain is unstable, and the quality and safety problems are prominent. In response to these problems, the fresh food supply chain quality control strategy is proposed from the aspects of supply chain operation mode, cold chain logistics infrastructure construction, supply chain cooperation mode, fresh product quality safety and standardization construction, aiming to enhance the safety of fresh food quality and promote the development of healthy dietary practices.*

Keywords: *Fresh Food, Supply Chain, Quality Control*

1. Introduction

Fresh food is an indispensable necessity in daily life. According to data from the National Bureau of Statistics, from 2016 to 2022, the per capita consumption of six major categories of fresh agricultural products in China (fresh vegetables, fruits, meat, aquatic products, dairy products, and poultry eggs) increased from 209.1kg to 245.6kg (he growth trend is depicted in Figure 1.), with a growth rate exceeding 15%. The per capita consumption of various types of fresh agricultural products showed an increasing trend [1]. With the increasing attention to personal health and food quality, the quality and safety issues of fresh food have become a major concern. The assurance of fresh food quality directly impacts consumer satisfaction and purchasing decisions [2]. However, China's fresh food supply chain faces numerous challenges to the quality and safety of fresh food. Fresh food supply demands high standards in storage, transportation, processing, and other aspects. It possesses unique characteristics, such as a high susceptibility to spoilage and deterioration, and freshness that changes over time [3]. The long-distance circulation poses extremely high risks to food quality and safety. Quality issues frequently occur in the actual supply process of fresh food, highlighting the urgent need to address quality control problems in its supply chain. Therefore, this paper will provide a detailed discussion on the quality control of the fresh food supply chain.

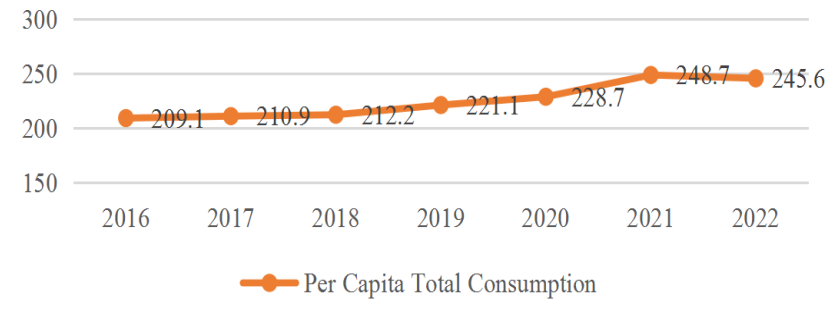

Figure 1: Total per capita consumption of six major categories of fresh agricultural products in China from 2016 to 2022 (unit: kg)

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2. Quality Issues in China's Fresh Food Supply Chain

2.1 The Supply Chain Has Many Circulation Links and Quality Control Is Difficult

Fresh food goes through a series of supply stages from basic suppliers to specific consumers [4]. In general, the supply chain process includes various stages such as production, transportation, processing, storage, and sales. As shown in Figure 2, the fresh food supply chain exhibits the characteristics of multiple stages and a long chain. In the actual flow process, fresh food relies on multi-level wholesale markets to achieve nationwide distribution, with multiple distribution paths separating the production end from the consumption end. The lengthy distribution process reduces the efficiency of the supply chain operation and, at the same time, increases the difficulty of quality control. Furthermore, various distribution channels intensify the difficulty of quality control in the process of fresh food circulation [5]. From the perspective of channel members, fresh food distribution channels can be divided into producer-led channels, wholesaler-led channels, retailer-led channels, large export processing enterprise-led channels, and wholesale market-led channels. Although there are differences in the circulation stages of various channels, they all face the common problem of having too many supply stages. Among them, the wholesaler-led distribution channel is the main channel for the circulation of fresh agricultural products in China, and it is also the distribution channel with the most levels.

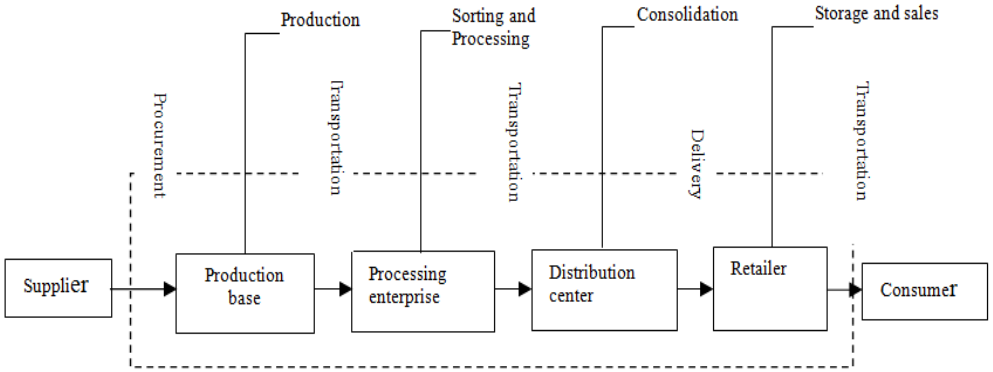

Figure 2: Fresh food supply chain flow chart

2.2 Fresh Food Cold Chain Technology is Lagging Behind, and the Rate of Product Preservation is Low

Cold chain circulation rates of fruits, vegetables, aquatic products, and meat in China are 35%, 68%, and 56% respectively, which are far lower than those in developed countries [6]. At the same time, long-distance transportation requires relatively complete cold chain infrastructure to ensure the quality of fresh products. From the perspective of the number of refrigerated trucks and cold storage, the number and inventory capacity of large-scale cold chain logistics enterprises in China are small. This results in the preservation rate of fresh products being much lower than that in developed countries, while the loss rate in the logistics and transportation process is much higher than that in developed countries (as shown in table 1) [7]. Additionally, due to limited inventory capacity, the phenomenon of "broken chain" for fresh products is severe (referring to the situation where fresh agricultural products become unsuitable for consumption due to irregular behaviors or inappropriate external factors such as temperature and humidity during freezing) [8]. This forces fresh supermarkets to reduce prices for poor-quality agricultural products.

Table 1: Product preservation ratio and transportation loss rate between China and developed countries (unit: %)

nation	Product freshness ratio	Transportation loss rate
China	30%	8%-15%
Developed countries such as the United States, Japan, and Europe	60%-75%	<5%

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2.3 Farmers are in a Vulnerable Position, Prone to Moral Risks of "Substituting Inferior for Genuine"

In the fresh supply chain, farmers often face financial constraints, operate at a small scale, and have relatively backward technology. Downstream enterprises in the supply chain, as the stronger party, may squeeze the profits of upstream farmers. Issues like "increased production without increased income" are common, causing losses to farmers' interests. This leads to the moral risk of "substituting inferior for genuine" as farmers try to compensate for their losses [9], resulting in quality issues in fresh food supply. Additionally, in family-based production, due to limitations in the capabilities and resources of family members, there is a contradiction between increasing quantity and improving quality at the same effort level. Farmers may face dilemmas where increasing production may reduce quality, or improving quality may reduce production. Under these circumstances, coupled with the lack of guarantee for farmers' income, farmers' enthusiasm for production decreases, and the quantity and quality of fresh food supply sources are not ensured.

2.4 Unstable Relationships in the Fresh Supply Chain, Highlighting Quality and Safety Issues

Due to the diverse categories of fresh products in China, the predominant production mode is still "small-scale farming" [10]. Under this production mode, farmers often lack market experience, and their production is experiential and somewhat blind. Controlling the quality and standardizing production of fresh food is challenging. Moreover, downstream processing enterprises, e-commerce businesses, and retailers often have simple buy-sell relationships with farmers, based on short-term interests. There is a higher risk of breaches in these relationships. In terms of interests, the connection between enterprises and farmers is not tight, making the supply chain relationship fragile. Many midstream and downstream enterprises have one-time buy-sell relationships with farmers or cultivation/raising enterprises. The quality of delivered products depends entirely on midstream and downstream circulation and processing enterprises. Clearly, such one-time relationships raise concerns about supplier selection. Studies have found that inappropriate supplier selection in food supply chains is one of the reasons for frequent food safety incidents [11]. Additionally, due to limited government regulatory capabilities, standardized control management is challenging, resulting in prominent issues of quality and safety in fresh food.

3. Fresh Food Supply Chain Quality Control Strategy

3.1 Innovate the Supply Chain Model and Optimize the Supply Process

This study relies on Internet technology to build intelligent supply chain (see Figure 3), change the traditional fresh supply chain operation mode, reduce supply links, and shorten the supply process. First of all, the government must do a good job in top-level design and overall planning, and provide policy, financial, legal and regulatory support for the establishment and improvement of the smart fresh food supply chain. At the same time, relevant government departments need to communicate well with all parties in all aspects to ensure supply.

Secondly, the creation of smart fresh supply chain involves farmers, agricultural production cooperatives, supply chain service platforms, logistics, retailers, communications and other levels. The fresh food supply chain management platform can be established to strengthen the information communication of all links of the supply chain and reduce the waste caused by the bullwhip effect. In order to realize centralized management using the supply chain management platform, it is necessary to increase the development of basic resources, record the information of each production link of agricultural products into the database, and build an information database that can be shared by enterprises and governments to facilitate product tracking and supervision. At the same time, an intelligent agricultural product industry base can be built on the upstream production side to facilitate the sharing of information and technology resources among various enterprises and achieve intensive utilization and optimal allocation of resources ;

Finally, the development of smart supply chain cannot be separated from technical support. It is necessary to accelerate the development of technology in each link of the supply chain and improve the efficiency of supply chain collaboration. On the one hand, it can accelerate the widespread application of modern information technologies such as three-network integration, the Internet, big data, and cloud computing in the production, processing, logistics, and sales of fresh food, create a smart fresh food

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system, and observe the production environment of fresh products in real time., intelligent control, government supervision[12]; On the other hand, this study vigorously promotes the construction of information service platforms such as e-commerce platforms, and uses the Internet to realize the integration of fresh resources and information sharing.

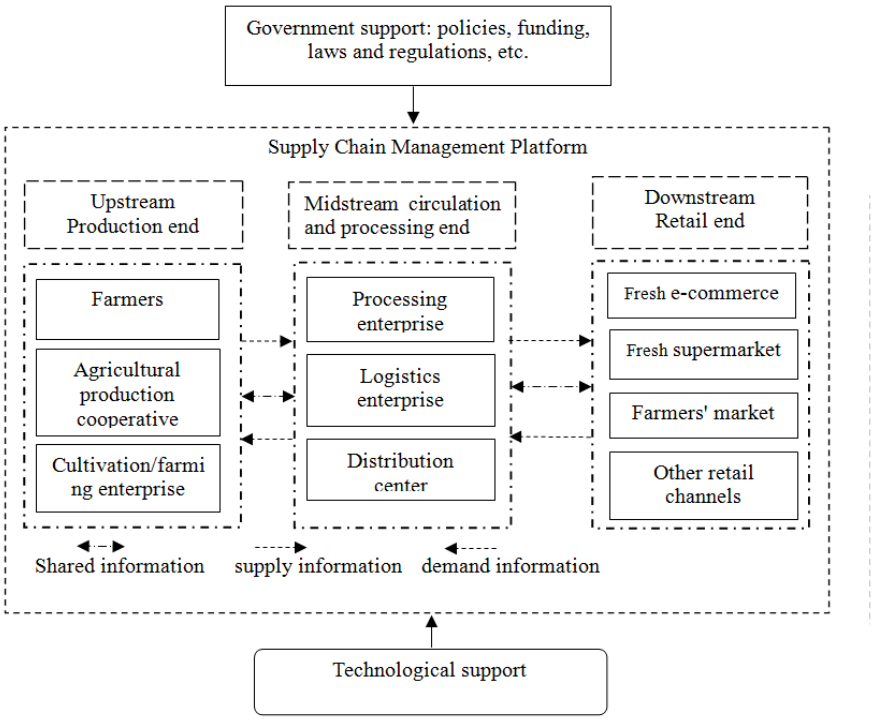

Figure 3: Smart supply chain operation model based on Internet technology

3.2 Increase the Construction of Cold Chain Logistics Infrastructure and Improve Logistics and Transportation Efficiency

First of all, under the existing production mode, this study increases the construction of cold chain inventory [13]. This study developed a small refrigerator according to the specific types of fresh food, which is suitable for the classification and storage of multi-variety and small-batch fresh food. The refrigeration adjusts the temperature according to the variety, changes the situation that the original single variety of perishable goods relies on large refrigerated trucks for transportation, improves the transportation efficiency of fresh food, and avoids the phenomenon of "broken chain".

Secondly, we should vigorously develop cold chain preservation technology to ensure that cold chain preservation is used in the entire process of fresh food from collection, storage and transportation, processing and manufacturing to distribution (Refer to Figure 4), so as to maintain product freshness to the maximum extent. The RFID tag information of each fresh product and environmental monitoring information can be obtained with the help of the Internet of Things application system, and the information can be recorded and improved at each stage, and the refrigeration equipment, temperature and humidity settings in the transport carriage can be adjusted in real time to ensure that the Product quality in transit.

Thirdly, the construction of cold chain logistics informatization is an important part of the construction of cold chain infrastructure, and the digital and informatization transformation of the cold chain logistics industry is a project with large investment scale, long cost recovery cycle, and high future comprehensive income. Fresh agricultural products, especially aquatic products, require cold chain logistics throughout the entire process from being salvaged ashore to the hands of consumers. The digitization of the cold chain logistics industry can improve the efficiency and visibility of the entire logistics process. The Internet of Things has developed rapidly in China in recent years. The Internet of Things technology can be applied to the cold chain logistics of fresh agricultural products. The use of Internet of Things technology can integrate cold chain logistics resources, increase the transportation speed of fresh agricultural products, and reduce product losses. This study advocates the digitalized joint distribution mode of fresh agricultural products, optimizes the distribution route of

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cold chain logistics, and reduces the cost of cold chain logistics [14]. We will promote agricultural supply-side reform, improve the efficiency of fresh agricultural products and reduce their distribution costs.

Finally, we must adapt to local conditions, optimize the layout of cold chain hub station facilities, accelerate the construction of a multimodal cold chain logistics system, improve the storage and transportation efficiency of fresh agricultural products, improve the connection between cold chain logistics main line transportation and branch line transportation, and improve transportation efficiency.

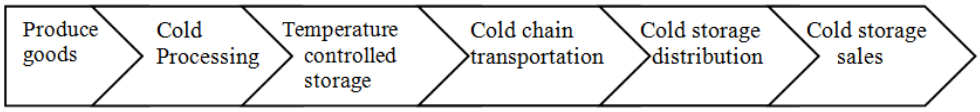

Figure 4: Cold chain preservation process diagram

3.3 Build a Mutually Beneficial Development Model for Farmers and Enterprises in the Upper, Middle and Lower Reaches

This study encourages qualified downstream enterprises to directly or indirectly invest in the construction of fresh food production bases with major fresh food production enterprises and agricultural production cooperatives to ensure the supply of fresh food raw materials from the source. It should also strengthen the development of leading processing enterprises and retail e-commerce enterprises, promote the development of farmers and agricultural cooperatives, form a complete farmer-farmer contact mechanism, and constantly increase farmers' income. It should also promote the industrialization and large-scale development of enterprises, and actively guide enterprises and farmers to form a community of interests through diversified development forms such as "share agriculture" and "profit return". In this way, we can achieve the goal of increasing the efficiency of leading enterprises and increasing farmers' income, and build a new model of mutual benefit and win-win. In addition, planting/breeding enterprises, processing enterprises and retailers can establish supply contract relationships [15], such as price contracts, quality contracts, etc., to ensure product quality while improving the overall profits of upstream, midstream and downstream enterprises.

3.4 Promote the Quality, Safety and Standardization of Fresh Products

This study strengthens the quality safety and traceability system management of fresh agricultural products, actively draws on existing mature international standards and norms, carries out special legislation for agricultural products traceability in China, and improves and innovates agricultural products traceability systems and mechanisms. It has also established a docking mechanism for origin access and market access based on the traceability platform, improved the response mechanism for agricultural product quality and safety issues, and promoted the application of technologies such as GS1 traceability language and RFID. It also promotes the standardization construction of agricultural production [16], formulates the classification and classification standards of different agricultural products, and utilizes the advantages of various agricultural products e-commerce platforms in collecting sales data and consumer evaluation information to promote the standardized production of upstream agricultural products. We will also strengthen brand integration and establish and improve agricultural product brand certification and reward mechanisms.

4. Conclusion

The demand for fresh food in my country is rising year by year. The quality control of the supply chain of fresh food affects food safety. This article analyzes the quality control issues of the existing fresh food supply chain and proposes a smart supply chain operation model and a full-process cold chain based on Internet technology. Fresh food supply chain quality control strategies such as preservation and building a mutually beneficial development model between downstream enterprises and farmers can effectively ensure the quality and safety of fresh food.

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