Application of computer information technology in food quality safety and detection

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Abstract: Nowadays, food safety problems have occurred frequently, and how to ensure food quality safety has become the focus of attention of the whole world. While computer information technology has become a necessary means to control food quality safety along with the continuous improvement of information degree. Computer information technology is the general term mainly used for the management and processing of information, including acquisition, processing, expression, communication, management and evaluation of information. In this paper, the application of computer information technology applied in food industry at home and abroad was mainly summarized, including query and retrieval related information of food science, stimulation of the production process to effectively control the potential risk factors, fast calculation in the process of food production and consumption, network platform design of sensory evaluation instead of complex manual work, and realization the whole process of full traceability for food industrial chain, so as to provide effective supervision channels for the government, establish food industrial traceability system, improve the information degree in food management and play the role of information technology in food safety management and realize the value.

Keywords: Computer Information Technology, Food Quality Safety, Food Quality Control, Traceability System

1. Introduction

In recent years, food safety issues have emerged continuously, from the "Sanlu Milk Powder" incident in 2008 to the "Soup Base Gate" of Wei Qian Ramen, toxic capsules, and some catering brands' ice colony detection exceeding the standard, all of which pose a serious threat to the life and health of consumers [1]. This series of exposed food safety incidents has also presented new challenges to China's food safety supervision system [2]. The main reasons for food quality and safety issues include environmental pollution at the source, backward testing technology, lack of a comprehensive food safety standard, and the legal awareness of practitioners is weak, among which the backward testing technology and the limitation of information collection are the main factors, while computer information technology can well make up for the deficiencies in current food safety supervision [3].

Food production involves many stages such as the production of raw materials, transportation, storage, processing, and sales, and each stage has potential food contamination hazards. Achieving a pollution-free traceable "farm-to-table" production chain throughout the entire process is inseparable from advanced computer information management methods and a detailed information sharing network [4]. Even rapid detection technologies such as loop-mediated isothermal amplification (LAMP) [5] and colloidal gold immunochromatographic test strips [6] cannot fully guarantee the safety and harmlessness of healthy food, therefore, the application of computer information technology in the food industry is very necessary.

Due to the many risk factors in the food production process and the large amount of information that needs to be recorded, relying solely on human supervision is insufficient. The advantages of computer information technology in information processing and collection, hazard link prediction and analysis, and the establishment of a traceable food production system can well make up for the shortcomings in supervision. For example: archiving information from all stages of food production, establishing a related file management information system to achieve full traceability, and providing consumers with a
transparent and searchable information interaction network [7]; establishing a large database for current new food safety laws and production technical indicators, providing information sharing for the food industry [8]; providing food producers and R&D departments of food companies with the latest technical information, providing a favorable environment for high-quality, safe, and reassuring food [9]; effectively improving the supervision strength of government and other regulatory departments, and quickly establishing a risk plan for sudden safety incidents. The powerful data system and rapid response to risk capabilities can bring great convenience to government departments for supervision [10].

2. The Importance of Computer Information Technology in Food Safety Control and Detection

In today's context of frequent food safety issues, how to quickly and accurately detect harmful links in the food production process and ensure food safety is the main problem that needs to be solved. Computer information technology is an effective means to solve such problems, and whether relevant laws and regulations are complete is a prerequisite for the accurate application of computer information technology in the food industry. In the current world, there are differences in the degree of informatization among countries. It is very necessary to learn from the information management models of developed countries and regions such as the United States, Japan, and the European Union to improve our country's relevant rules and regulations [11]. Taking the United States as an example, its food safety management system is relatively complete. The U.S. Food and Drug Administration (FDA) is responsible for food safety except for meat and poultry products, the United States Department of Agriculture (USDA) is responsible for the food safety of meat and poultry, and the U.S. Environmental Protection Agency is responsible for the safety of drinking water and the management of pesticide and other chemical residue limits [12]. The U.S. Congress passed the "Public Health Security and Bioterrorism Preparedness and Response Act of 2002" [13], under which a total of four clauses are related to the protection and management of food supply. They are Article 303, 305, 306, and 307. Among them, Articles 305 and 306 involve the management application of computer information technology in the food industry. Article 305 Registration stipulates that all U.S. and foreign enterprises engaged in the production, processing, packaging, and storage of food and animal feed must complete registration with the FDA before the specified time limit; Article 306 Recordkeeping stipulates that all registered food enterprises must establish and maintain a complete record of information from the source, transportation, and final sale of the entire production chain, and make it transparent and traceable to trace the source of food. In the event of a food safety issue, it can be immediately traced to a specific link [14]. Japan and the European Union have also proposed relevant regulations on the application of computer information technology in food quality safety and detection, such as the "Japanese Agricultural Standard Law" (JAS Law) [15] proposed by the Japanese government in 2006 and the "General Food Law of the European Union" [16] which officially came into effect in 2002. Their relevant laws and regulations have a high reference value for improving China's food quality safety regulations. The strict regulations of developed countries on computer information technology also confirm the extensive application of computer information technology and its importance in the application of food quality safety and detection.

Compared to developed countries, China's establishment of regulations on the application of computer information technology in food quality safety and testing is relatively lagging, and the requirements for the traceability process records throughout the food production chain are not very clear, with a relatively narrow scope of relevant laws and regulations. So far, China has only promulgated a few laws and regulations related to the application of computer information technology in the food industry, such as the "Food Safety Law" [17], "Food Safety Law Implementation Regulations" [18], and "Good Manufacturing Practice for Dairy Enterprises" [19]. Although since the revision and implementation of the "Food Safety Law" in 2015 [20], the overall situation of China's food safety has improved significantly, with the sampling pass rate increasing by 2.1 percentage points compared to 2014 [21], there are still some prominent issues.

The application of computer information technology in China's food safety control mainly requires enterprises to maintain corresponding information records and retention for their product production.
process. Based on the principle of Hazard Analysis and Critical Control Point (HACCP), computer information technology is applied to monitor relevant critical control points and record the test results. However, there are still fatal problems in the production details. Firstly, grassroots food supervision and management departments lack technical support and professional judgment ability; secondly, the quality of the test reports issued is uneven, and the standards are somewhat overlapping and repetitive, with some small testing institutions issuing false reports; in addition, with the prevalence of online food ordering, some small traders and small-scale restaurants cannot record information in time, and the food quality safety cannot be guaranteed. Therefore, the relevant provisions on the application of computer information technology in the food industry need to be supplemented and improved.

3. Application of Computer Technology in Food Quality Safety and Detection

3.1. Computer Information Technology Based on the HACCP Principle

HACCP is an economical and effective management system for controlling food safety. China first participated in the HACCP and new seafood inspection standards seminar held by the U.S. FDA, NOAA, and NFI as early as 1991. The application of computer information technology in the HACCP management system in the food industry mainly involves generating a production process chart according to the production and processing links, and performing operable control at the corresponding critical control points. Computer information technology based on the HACCP principle mainly uses planning software and execution software. The planning software is mainly responsible for conducting hazard analysis and determining critical control points, and improving controllable conditions according to actual product production operations [22]. The execution software is mainly responsible for controlling each identified critical control point, collecting the control status of each key point, recording and retaining monitoring results, and automatically correcting any issues that arise in a timely manner. The operation of computer information technology based on the HACCP principle in the production process of food enterprises can effectively prevent the occurrence of food quality and safety issues, and provide a platform for the traceability of the entire production process and the public transparency of information networks [23].

3.2. Computer Vision-based Food Quality Detection Technology

Computer vision technology is a type of computer information processing technology that uses computer programs to implement the visual functions of humans, to perceive, recognize, and understand the three-dimensional scenes of the objective world [24, 25]. Computer vision can be simply understood as replacing human eyes with cameras and replacing the human brain with software processing programs to complete the identification and appraisal of targets. Its image processing can be roughly classified into three aspects: image processing, image analysis, and image understanding [26]. Image processing is a low-level processing of the obtained scene images, enhancing the visual effect of the images and involving the processing of large amounts of data; image analysis is the second stage, where the computer software program achieves the transformation from images to computer language, facilitating the software to analyze and process the provided images for detection, extraction, and measurement; image understanding is the highest-level stage, where the analysis of the provided images combines various related properties for study, similar to human brain thinking and reasoning, and the results obtained can provide reference significance for food quality testing.

To date, computer vision technology has been widely used in the quality detection of agricultural products and the monitoring of biological growth states. Yuan Wei peng et al. [27] used color detection for cigarette paper spots, establishing an image segmentation and inspection method based on color space transformation; Li et al. [28] used computer vision technology for feature extraction and matching of tomato plants; Brosnan et al. [29] established an agricultural product detection system based on computer vision technology. The application of computer vision technology in the food industry has greatly reduced manpower and has extensive social and economic benefits.
3.3. Research on Food Production Line Simulation Based on Computer Information Technology

Under the new economic conditions, food companies are facing unprecedented challenges. Traditional production capacity planning methods have become outdated. With the development of computer information technology, applying information technology to assist food companies in capacity planning enables them to flexibly adjust food packaging, taste, and production volume according to changes in consumer demand, while ensuring productivity and improving food quality [30, 31].

The capacity planning of food companies traditionally relies on static capacity models, but with the continuous improvement of informatization, traditional methods can no longer adapt to the highly variable consumer demands. There is a significant waste of time and labor. Simulation methods, on the other hand, can perfectly handle various random factors in the capacity planning of food companies, meeting market demands in a timely manner. The basic steps of a simulation system mainly include model construction, data collection, model transformation, verification and validation, model operation, and simulation result analysis, etc., ultimately providing the optimal capacity planning solution based on the collected data [32]. Using simulation models based on computer information technology, effective monitoring of risk links in the food production line can be achieved, and adjustments can be made in a timely manner before problems occur, which has great research value in today's food industry [33].

3.4. Traceable Food Production Chain System Based on Computer Information Technology

Following the entire process from "farm to table," which includes the production, processing, storage, transportation, and sales of food, and tracing back in the event of food quality and safety issues, computer information technology provides an effective information sharing network platform [34-36]. A traceable food production chain system based on an Information Management System (IMS) can achieve full traceability of products. By adopting the EAN.UCC barcode system established by the European Article Number and the Uniform Code Council, effective identification of products and their attribute information, participant information, etc., throughout the entire food supply chain can be achieved. This allows for tracking and control at each stage, enabling timely and accurate tracing of problem links in the event of quality and safety issues, thereby reducing the regulatory workload of government departments [37, 38].

In addition to the Information Management System, computer information technology based on Radio Frequency Identification (RFID) can also achieve full traceability of the production chain [39, 40]. Radio frequency technology mainly consists of three parts: RFID tags, readers, and computers. The entire system can achieve automated management of food goods, including warehousing, inventory, stocktaking, and shipping, maximizing the management efficiency of food warehouses [41-43]. Radio frequency technology can also encode and store information about each link in the food production chain, establishing an information exchange network. Various enterprises, relevant personnel, and consumers can use electronic tags to access the entire production process of the corresponding product in the production chain database, thereby achieving full traceability [44, 45].

4. Issues and Suggestions for the Application of Computer Information Technology in Food Quality Safety and Detection in China

4.1. Relevant Laws and Regulations Still Need to Be Improved

At present, there are no mandatory legal requirements for the technical applications of food companies in China. The awareness of food quality safety among consumers and producers is not high, and despite the implementation of the new Food Law, food safety issues continue to occur [46]. Therefore, the government and relevant food regulatory departments need to improve relevant laws and regulations, production standards, and implementation guidelines in the field of food industry informatization. There are many small and medium-sized enterprises (SMEs) in China, and few operators of these SMEs have a sufficiently advanced concept and literacy of computer information technology. Therefore, proposing different regulations according to the different characteristics of enterprises of different scales, especially SMEs, can maximize the promotion of the application of computer information technology in food quality safety and testing [47, 48]. In addition, the Chinese government and relevant food regulatory departments can use computer information technology to establish a comprehensive traceability system for the food
production chain and make detailed provisions for each link from raw materials to output to ensure the quality and safety of food in China [49].

4.2. Strengthening Technical Support for Food Companies

China's food quality safety detection methods are relatively backward compared to those of developed countries, and computer information technology can provide technical support for new rapid food quality safety detection methods [50]. Currently, China's food production and operation are scattered, with a low degree of organization and a long food supply chain, which hinders the application of computer information technology. Therefore, computer software developers should develop targeted traceable software with information collection and sharing attributes according to the production requirements and process characteristics of different enterprises. While developing the corresponding software, China's food quality safety-related laws and regulations can be integrated into the information system to expand the application of computer information technology in food quality safety and testing, and improve China's food safety management level [51, 52].

4.3. Increase the Promotional Efforts for Food Companies

The scale of food companies in China varies, and there is a significant difference in the level of informatization. Large enterprises have a higher degree of informatization and have mostly applied computer information technology to the management of food production processes, while the popularity of computer information technology in the management systems of most small and medium-sized enterprises is not high. Moreover, most management personnel do not have the awareness to use computer data technology for enterprise management. Therefore, increasing the promotional efforts of computer information technology in enterprise management is of great importance [53]. In addition, small-scale enterprises also lack corresponding technical personnel, and the existing management personnel are not familiar with computer information technology. Therefore, it is very necessary to introduce new technical talents and provide corresponding training for existing employees [54].

5. Conclusion

In the current era rife with food safety issues, it is crucial to be able to quickly and accurately trace the origins of these issues or to address risk factors before they lead to food safety problems. Computer information technology, with its robust network for information exchange and its capabilities in simulation and emulation, can realize a fully traceable system throughout the food industry chain. By applying the right software, it can identify key control points and enhance the quality and safety of food.

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