

Construction and Practice of Intelligent Preservation Technology System for Agricultural and Forestry Products after Harvest

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Abstract: This article focuses on the problem of postharvest preservation of agricultural and forestry products, and explores the construction and practice of intelligent preservation technology system. On the basis of expounding the losses caused by poor preservation of agricultural and forestry products after harvest and the development background of intelligent preservation technology, this article deeply analyzes the theoretical basis of intelligent preservation technology system. It covers the principle of postharvest physiological changes of agricultural and forestry products, key environmental factors affecting preservation and related technical and theoretical support. By constructing a technical system framework composed of environmental monitoring, precise regulation, data management and intelligent decision-making subsystems, the strategies of sensor technology optimization, precise regulation implementation, data management and intelligent decision-making application are put into practice. The research results show that the system can effectively integrate various technologies, realize accurate and intelligent control of the preservation process of agricultural and forestry products, and is expected to reduce post-harvest loss and improve product quality and market competitiveness. This provides a scientific and effective solution for postharvest preservation of agricultural and forestry products in China.

1. Introduction

As an important material basis of human life, the preservation of agricultural and forestry products after harvest has always been concerned. Under the current social and economic development situation, the output of agricultural and forestry products continues to increase, but the losses caused by improper post-harvest preservation are amazing. This not only leads to the waste of resources, but also has a negative impact on farmers' income and market supply stability [1-2]. In this context, the development of intelligent preservation technology provides a new way to solve this problem.

From a global perspective, developed countries have already started in-depth research and wide application of intelligent preservation technology, and many advanced intelligent preservation equipment and systems have been put into the market, which has significantly improved the preservation effect and economic benefits of agricultural and forestry products [3]. On the other hand, although China has made some progress in the field of intelligent preservation technology, there is still a gap compared with the international advanced level, especially in terms of technology integration and systematic construction. It is of great significance to construct the intelligent preservation technology system of agricultural and forestry products after harvest [4]. On the one hand, it helps to reduce the post-harvest loss of agricultural and forestry products, improve the utilization rate of resources, ensure the effective supply of agricultural products, stabilize market prices, and then promote the sustainable development of agriculture [5]. On the other hand, it can enhance the competitiveness of China's agricultural products in the international market and

promote the export of agricultural products to earn foreign exchange [6]. In addition, the construction of intelligent preservation technology system will also drive the development of related industries and create new economic growth points.

The purpose of this study is to deeply discuss the construction and practice of intelligent postharvest preservation technology system of agricultural and forestry products. By combing the relevant theoretical basis, building the technical system framework and studying the key technologies and strategies, it is expected to provide scientific and effective solutions for postharvest preservation of agricultural and forestry products in China and promote the agricultural modernization process in China to a new level.

2. Theoretical basis of intelligent preservation technology system

A series of physiological changes will occur in agricultural and forestry products after harvest, and respiration is the key link. Take the fruit as an example. After harvest, the fruit still breathes, consumes oxygen and releases carbon dioxide, and its rate affects the process of fruit ripening and senescence [7]. At the same time, ethylene, as a plant hormone, can significantly promote fruit ripening. Such as banana, the increase of ethylene production will accelerate the respiratory jump of the fruit and promote the rapid ripening and softening of the fruit. Understanding these physiological changes is an important prerequisite for building an intelligent preservation technology system.

Temperature has great influence on the preservation of agricultural and forestry products. Suitable low temperature can reduce the respiratory rate of products and delay aging, but too low temperature may lead to chilling injury. Humidity is also a key factor, too high humidity can easily lead to microbial growth, leading to product decay; If it is too low, the product will lose water and wilt [8]. In addition, the concentrations of oxygen and carbon dioxide in gas components have a significant impact on the preservation effect. Proper reduction of oxygen concentration and increase of carbon dioxide concentration can inhibit respiration, but improper concentration can also cause physiological obstacles.

Sensing technology is the basis of intelligent preservation, and all kinds of sensors can monitor environmental parameters and product physiological indexes in real time. Such as temperature and humidity sensors, gas sensors, etc., to provide data support for precise regulation. The control technology accurately adjusts the environmental conditions according to the sensor data to ensure that the fresh-keeping environment is suitable [9]. Information technology is responsible for data storage, analysis and management, and decision support is realized through intelligent algorithms, which makes the preservation process more intelligent and scientific [10]. These technologies cooperate with each other to form the theoretical basis of intelligent preservation technology system.

3. Construction of intelligent preservation technology system framework

The post-harvest intelligent preservation technology system of agricultural and forestry products is a complex and interrelated system, and its framework construction aims to integrate various technologies and realize accurate and intelligent control of the preservation process of agricultural and forestry products. The system is mainly composed of environmental monitoring subsystem, precise regulation subsystem, data management and intelligent decision subsystem. The subsystems cooperate with each other to ensure the best fresh-keeping environment for agricultural and forestry products after harvest.

(1) Environmental monitoring subsystem

The environmental monitoring subsystem is like the "eyes and ears" of the system, which is responsible for obtaining the key information of the storage environment and its own state of agricultural and forestry products in real time. This subsystem uses a variety of advanced sensing technologies to accurately monitor environmental parameters such as temperature, humidity, gas composition (oxygen, carbon dioxide, ethylene, etc.), light intensity, and physiological indicators of

agricultural and forestry products such as hardness and sugar content. The temperature sensor can accurately sense the slight change of temperature in the storage space, and the accuracy can reach 0.1°C. The gas sensor can quickly and accurately detect the concentrations of oxygen and carbon dioxide, and provide data support for regulating the gas environment. By reasonably arranging sensor nodes in the storage space, the environmental parameters can be monitored in all directions without dead ends, and the accuracy and comprehensiveness of the obtained data can be ensured.

(2) Precise control subsystem

According to the data fed back by the environmental monitoring subsystem, the precise control subsystem makes targeted adjustments to the storage environment to create the most suitable conditions for the preservation of agricultural and forestry products. The subsystem covers many aspects such as temperature control, humidity control, gas composition control and illumination control.

In the aspect of temperature control, intelligent refrigeration and heating equipment is adopted, which can be automatically adjusted according to the set temperature range to ensure that the temperature fluctuation is controlled within a very small range. Humidity control is to maintain the humidity at an appropriate level through the cooperation of humidifier and dehumidifier. Gas composition control with the help of controlled atmosphere equipment, the concentration of oxygen, carbon dioxide and ethylene can be accurately adjusted. Lighting regulation for some agricultural and forestry products sensitive to light, intelligent shading or light supplement devices are adopted to meet their specific lighting needs.

(3) Data management and intelligent decision-making subsystem

The subsystem of data management and intelligent decision-making is the "brain" of the whole system. It is responsible for storing, analyzing and processing the data collected by the environmental monitoring subsystem, and making intelligent decisions according to the analysis results to guide the work of the precise control subsystem. The subsystem uses advanced technologies such as big data, cloud computing and artificial intelligence to build a data model and mine the potential laws behind the data.

Based on the analysis of environmental parameters and physiological index data of agricultural and forestry products in different varieties and storage stages, the optimization model of preservation parameters was established, which provided scientific basis for precise regulation. Intelligent decision-making module can automatically generate the best control strategy according to real-time data and historical experience, and realize intelligent and automatic preservation management. Figure 1 shows the subsystems and their functional relationships of the intelligent preservation technology system framework:

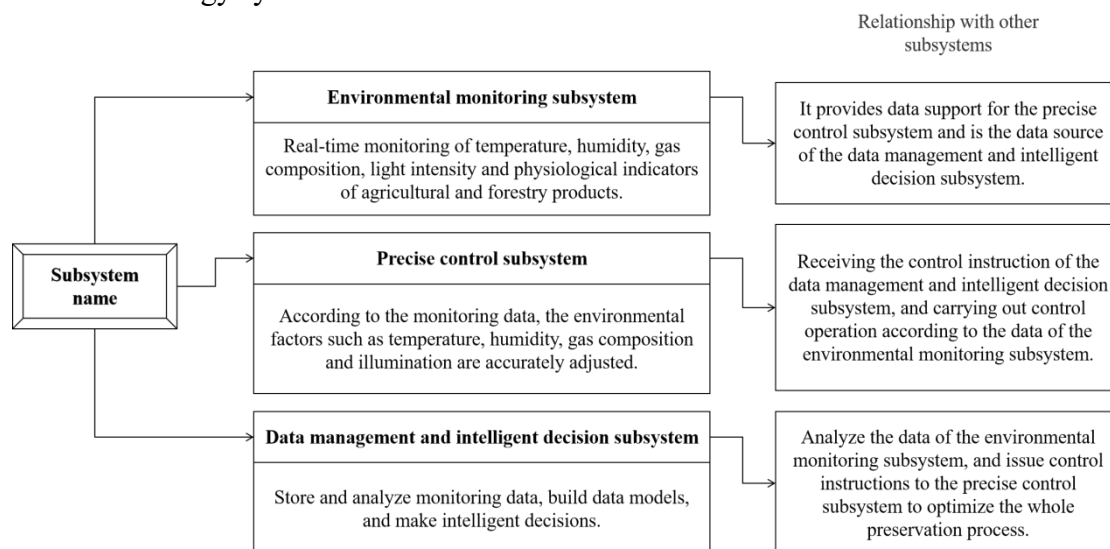


Figure 1 Functional relationship of framework subsystem of intelligent preservation technology system

Through the organic combination of the above three subsystems, the intelligent preservation

technology system can realize comprehensive, accurate and intelligent management of the postharvest preservation process of agricultural and forestry products, effectively extend the preservation period of agricultural and forestry products, reduce postharvest loss, and improve product quality and market competitiveness.

4. System construction strategy and practice

(1) Optimization strategy and practice of sensing technology

As the front-end sensing link of intelligent fresh-keeping system, the accuracy and stability of sensing technology are very important. In practice, according to the characteristics of different agricultural and forestry products and the requirements of fresh-keeping environment, it is necessary to choose and arrange sensors reasonably. For fruits sensitive to ethylene, such as apples and pears, high-sensitivity ethylene sensors should be used to monitor the change of ethylene concentration in real time.

In the sensor layout, the principle of combining uniformity with key areas is followed. Taking a large-scale cold storage as an example, temperature and humidity sensors are arranged at different heights, corners and densely packed areas in the warehouse to ensure comprehensive and accurate acquisition of environmental temperature and humidity information. In order to better show the application scenarios of different sensors, Table 1 is specially formulated. Reasonable selection and layout of sensors can effectively improve the monitoring accuracy of environment and product status, and provide reliable data for subsequent precise regulation.

Table 1: Suitable Sensor Types for Different Agricultural and Forestry Products

Agricultural and Forestry Product Category	Key Monitoring Indicators	Suitable Sensor Types
Fruits	Ethylene concentration, temperature and humidity, hardness	Ethylene sensor, temperature and humidity sensor, hardness sensor
Vegetables	Moisture content, gas composition (oxygen, carbon dioxide)	Moisture sensor, gas sensor
Grains and Cereals	Humidity, pest infestation	Humidity sensor, pest monitoring sensor

(2) Precise control strategy and practice

Accurate regulation is the core link to achieve good preservation effect of agricultural and forestry products. Taking temperature control as an example, according to the difference of suitable storage temperature of different agricultural and forestry products, a personalized temperature control scheme is formulated. For tropical fruits such as mango, the storage temperature is generally controlled at 10-13°C; The suitable storage temperature of leafy vegetables is 0-4°C.

Humidity control is equally important. Too high humidity can easily lead to mold growth, while too low humidity can lead to product dehydration. By installing humidifier and dehumidifier, it can be automatically adjusted according to the monitored humidity data. In terms of gas composition control, for modified atmosphere storage, the concentrations of oxygen and carbon dioxide are accurately adjusted according to product demand. Table 2 shows the modified atmosphere preservation parameters of some products:

Table 2: Controlled Atmosphere Storage Parameters for Common Agricultural and Forestry Products

Agricultural and Forestry Product Name	Oxygen Concentration (%)	Carbon Dioxide Concentration (%)
Strawberries	3-5	5-8
Broccoli	2-4	5-7
Grapes	2-3	3-5

In practice, by integrating temperature and humidity, gas composition and other control equipment, an intelligent control network is constructed to realize multi-parameter coordinated and accurate control of fresh-keeping environment.

(3) Data management and intelligent decision-making strategy and practice

Data management and intelligent decision-making provide scientific decision support for

intelligent preservation system. In data management, a special database is established to store the data collected by sensors in real time, and classify and back it up. Using data analysis technology, the potential correlation between data, such as the relationship between ambient temperature and product respiration rate, is mined.

Based on the data analysis results, the intelligent decision-making module combines expert experience and preset preservation model to automatically generate control instructions. When it is detected that the ethylene concentration in the fruit storage environment rises and the temperature rises slightly, the decision-making module automatically gives instructions to reduce the temperature and adjust the gas composition appropriately to inhibit the fruit ripening process. By continuously optimizing the data model and decision-making algorithm, the accuracy and timeliness of intelligent decision-making are improved, and the efficient operation and precise management of intelligent preservation system are realized.

5. Conclusions

In this article, the intelligent preservation technology system of agricultural and forestry products after harvest is studied in depth, aiming at solving the serious loss of agricultural and forestry products after harvest and promoting the development of agricultural modernization in China. Through the discussion on the theoretical basis of intelligent preservation technology system, the post-harvest physiological changes of agricultural and forestry products, key environmental factors and related technical theoretical basis were clarified, which provided a solid theoretical support for the system construction.

In the construction of technical system framework, a complete framework is created, which is organically combined with environmental monitoring, precise regulation, data management and intelligent decision-making subsystem. Environmental monitoring subsystem uses a variety of sensing technologies to obtain key information in real time. The precise control subsystem adjusts the environmental factors according to the monitoring data. The data management and intelligent decision-making subsystem is responsible for data processing and decision-making, which realizes comprehensive and intelligent management of the preservation process. In the strategy and practice of system construction, through reasonable selection and layout of sensors to optimize the sensing technology, personalized and precise control schemes are formulated according to the characteristics of different agricultural and forestry products, and with the help of efficient data management and intelligent decision-making, the operation efficiency and preservation effect of the system are effectively improved.

To sum up, the intelligent preservation technology system of agricultural and forestry products after harvest has a solid theoretical foundation, reasonable framework design and feasible strategy. It is expected to significantly reduce the post-harvest loss of agricultural and forestry products, improve the utilization rate of resources and enhance the competitiveness of China agricultural products in the international market. However, in practical application, the system may still face challenges such as cost control and unification of technical standards, and further research and improvement are needed in the future to achieve wider application and development.

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