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Effect of Different Processing Methods on Storage Quality of Strawberries

Jun WANG *, **Feng MIAO**, **Rui ZHOU**

College of Life Science, Cangzhou Normal University, Cangzhou 061001, China; 2. Cangzhou Academy of Agriculture and Forestry Sciences, Cangzhou 061001, China

Abstract [**Objectives**] This study aimed to explore the effect of different processing methods on the storage quality of strawberries. [**Methods**] Strawberries purchased from Xintongtian Supermarket in Cangzhou City were used as the experimental material, and they were subjected to different processing methods: 45 ℃ hot air for 30 min, 45 ℃ hot water for 10 min and 3% calcium chloride for 1 min. [**Results**] The processing effect of 45 ℃ hot water for 10 min was better than that of 45 ℃ hot air for 30 min. The processing effect of 3% calcium chloride for 1 min was good. Hot water processing could prolong the time to begin to rot, obviously alleviate the increase in weight loss rate, and obviously alleviate the decrease of soluble solids and Vc contents of strawberry fruit. However, the ability of hot water to delay the decrease of strawberry fruit hardness was not as good as that of calcium chloride. [**Conclusions**] The strawberries processed with 45 ℃ hot water for 10 min showed the best storage quality.

Key words Strawberry, Hot water, Hot air, Calcium chloride, Preservation

1 Introduction

Strawberry (*Fragaria ananassa* Duch.), also known as Yangmei, is a plant in the Rosaceae. It is a perennial evergreen plant. The fruit is sweet and delicious, rich in nutrition. Strawberry fruit contains fructose, sucrose and a variety of vitamins[1]. The ripening period of strawberry is relatively early. Strawberries are a good nourishing product, which is deeply loved by consumers. They can also be processed into sauce, wine, fruit tea drinks, quick-frozen food, *etc.*, with very broad market[2]. Strawberry fruit has very high water content, and the fruit skin is thin, without hard skin protection. As a result, it is very easy to be damaged. After strawberry fruit is stored at room temperature (25 ℃) for 1 –2 d, the color will change, the taste will change, some rot will appear, and the commodity will decrease, severely restricting the sale and storage of strawberries[3].

At present, the preservation of fruits and vegetables mainly starts from the three stages of pre-production, middle and late stages. In order to improve the storage durability and then extend the storage time, among the three stages, preservation after harvest has always been a key issue in the preservation of fruits and vegetables. In recent years, varieties represented by strawberry have developed rapidly. People have a new understanding of the nutritional value of strawberries. As a result, the demand for strawberries in domestic and foreign markets has increased. There are many researches on the fresh-keeping technology of strawberry fruit. At present, the commonly used domestic strawberry preservation methods include low temperature storage, radiation storage, film packaging and chemical preservation[4]. The costs of low temperature storage and film packaging are relatively high, and radiation storage may have an impact on human health.

Because of the increasing demand for green food, heat processing, as a pollution-free fruit preservation technology, is attracting widespread attention. Heat processing before storage has bactericidal effect on fruits, and it can extend the storage period and maintain the quality of the fruit after harvest[5]. The advantage of chemical method is that it is convenient to operate and does not require specific equipment. As an efficient and non-toxic bactericide, calcium chloride can effectively kill bacterial propagules, and the processed strawberries are not harmful to human health. At present, there are many studies on the effect of heat processing and calcium chloride processing on the storage quality of strawberry fruit. However, which treatment has a better effect on the post-harvest storage quality of strawberry fruit has been rarely reported so far[6]. For this reason, taking strawberry fruit as the experimental material, this experiment explored the effect of hot water processing (45 ℃, 10 min), hot air processing (45 ℃, 30 min) and calcium chloride processing (3%, 1 min) on the storage quality and screened out the most suitable method to keep strawberries fresh after harvest, in order to achieve the purpose of improving the economic benefits of strawberries.

2 Material and methods

2.1 Material In this experiment, strawberry fruit purchased at Xintongtian Supermarket was used as the experimental material.

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* Corresponding author. Jun WANG, master, lecturer, engaged in research on the extraction of biological active ingredients in plants.

Editorial Office E-mail: asiaar@163.com

2.2 Methods

2.2.1 Material processing. Hot air processing: After removing impurities from strawberry fruits with basically the same size and maturity, no diseases and insect pests, and no mechanical damage, 6 groups of strawberries, 200 g for each group, were weighed. The strawberries were placed in white porcelain dishes, wrapped with plastic film, placed in a digital display blast drying oven, processed with hot air at 45 ℃ for 30 min, and observed at room temperature successively. The physiological and biochemical indices of the strawberries after hot air processing were measured.

Hot water processing: After removing impurities from strawberry fruits with basically the same size and maturity, no diseases and insect pests and no mechanical damage, 6 groups of strawberries, 200 g for each group, were weighed. The strawberries were processed with hot water at 45 ℃ for 10 min. After processing with hot water, the strawberries were placed in a ventilated place for 3 – 4 h until the moisture on the surface of the strawberries was air-dried, cooled to room temperature, wrapped with plastic film, and observed at room temperature. The physiological and biochemical indices of the strawberries processed with hot water were measured[7].

Calcium chloride processing: After removing impurities from strawberry fruits with basically the same size and maturity, no pests and no mechanical damage, 6 groups of strawberries, 200 g for each group, were weighed, and processed with 3% calcium chloride for 1 min, respectively. After processed, the strawberries were placed in a ventilated place for 3 – 4 h until the moisture on the surface of the strawberries was air-dried, cooled to room temperature, wrapped with plastic film, and observed at room temperature. The physiological and biochemical indices of the strawberries were measured.

2.2.2 Evaluation of sensory flavor. The sensory flavor of strawberry was graded from the four aspects of color, flavor, appearance and texture[8 – 10].

The grading criteria were as follows. 5 points: The strawberry fruit is red or reddish yellow, and there is no mechanical damage on the surface. There is a strong strawberry aroma, a certain degree of hardness, and no rotten strawberry fruit. 4 points: The strawberry fruit is bright red, with a light aroma and a certain degree of hardness. There is no rotten strawberry fruit. 3 points: The strawberry fruit is red, the strawberry skin shrinks, and the hardness begins to decrease. 2 points: The strawberry fruit is darkened, with some water-soaked spots. The aroma is lost. Some fruits are moldy. 1 point: The strawberry fruit is soft and rotten, with a rotten smell. 0 point: The strawberry fruit is severely rotted and smells bad.

2.2.3 Determination of weight loss rate. The weighting method was used. Strawberries in groups, 200 g for each group, were weighed. After different processing, the weight of the strawberries was measured every 24 h. The weight loss rate was calculated according to the following formula:

Weight loss rate (%) = [(Weight of fruit before storage – Weight of fruit after a certain period of storage)/Weight of fruit before storage] × 100%[11 – 13]. (1)

2.2.4 Determination of hardness. It is measured by a hardness tester (GY-4).

Three strawberries were randomly selected from the strawberries processed by different method, respectively for determination of hardness. Two points were selected on the shoulder of each strawberry, and the hardness tester was inserted into each of them, and the readings were recorded. Each replicate was measured three times[14].

2.2.5 Calculation of decay index. According to the size of the decay area of the fruit, it can be divided into four levels[15]. Level 0: No decay. Level 1: The decay area of the fruit is less than 25% of the total area of the fruit. Level 2: The decay area of the fruit accounts for 26% – 50% of the total area of the fruit. Level 3: The decay area of the fruit is greater than 50% of the total area of the fruit.

Decay index (%) = ∑ (Number of decayed fruits × Value of decay level)/Total number of fruits × Value of highest decay level × 100. (2)

2.2.6 Determination of soluble solids content. Soluble solids content was determined with digital Abbe refractometer (WAY-2S). Three strawberries were randomly selected from the strawberries processed by different method, respectively. The pulp was collected using a scalpel and placed in a mortar to grind. The ground pulp was filtered with two layers of gauze once to squeeze out the strawberry juice. One drop of the strawberry juice was loaded to the digital Abbe refractometer, and the refractive index was recorded and converted into soluble solids content[16].

2.2.7 Determination of Vc content. Content of Vc was determined using ultraviolet absorption method. To determine the maximum absorption wavelength, an accurate volume of Vc standard solution was transferred into the cuvette and scanned multiple times in the wavelength range of 200 – 400 nm, using distilled water as the blank. The maximum absorption wavelength of Vc was determined to be 265 nm. Therefore, the absorbance of the Vc sample solution was measured at 265 nm.

Different volume (0.00, 1.00, 2.00, 4.00, 6.00, 8.00, 10.00 and 12.00 mL) of Vc standard solution was diluted to 100 mL, respectively. The absorbances of the diluents at 265 nm were determined, with distilled water as a reference. With absorbance as the ordinate and concentration of Vc standard solution as the abscissa, the standard curve was drawn[17].

3 Results and analysis

3.1 Sensory flavor As shown in Table 1, with the extension of storage time, after hot water, hot air and calcium chloride processing, the sensory flavor of strawberries decreased and showed differences. The sensory flavor of the strawberries processed by different methods did not decreased on days 1 and 2, all maintained at 5 points. The sensory flavor of the strawberries processed by different methods began to show a downward trend on day 3.

The declining trends of sensory flavor of the strawberries processed with hot air and calcium chloride were basically the same. The sensory flavor of strawberries processed with hot water was obviously the best. It shows that hot water processing can better maintain the sensory flavor of strawberry fruit.

Table 1 Changes in sensory flavor of strawberry fruit processed by different methods

Storage time//d	Score of hot water processing points	Score of hot air processing points	Score of calcium chloride processing points
1	5	5	5
2	5	5	5
3	4	4	3
4	4	3	3
5	3	2	2
6	2	1	1

3.2 Weight loss rate As the storage time increased, the weight loss rate of the strawberries processed with hot water, hot air and calcium chloride increased and showed differences (Fig. 1). From day 1 to day 3, the weight loss rate of the strawberries processed by different method all increased significantly, while no significant difference was observed. From day 4 on, the weight loss rates of the strawberries processed with hot air and calcium chloride were significantly higher than that processed with hot water, indicating that hot water processing can delay the weight loss of strawberries to a greater extent and keep strawberries fresh and tender.

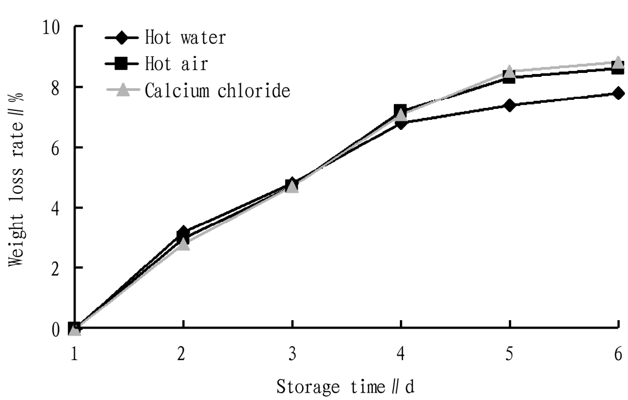

Fig. 1 Dynamics in weight loss rate of strawberry fruit processed with different methods

3.3 Hardness As the storage time increased, the hardness of the strawberries processed with hot water, hot air and calcium chloride all decreased to varying degrees, leading to fruit softening and storage performance decline (Fig. 2). From day 1 to day 6, the hardness of the strawberries processed with hot water and hot air decreased significantly, and the degree of decrease was roughly similar. The hardness of the strawberries processed with calcium chloride also decreased to a certain extent, but the decrease was smaller than the decreases of strawberry hardness after hot water and hot air processing. It shows that calcium chloride processing can delay the decrease of strawberry hardness to a greater extent, inhibit the softening of strawberries and improve the storage performance of strawberries.

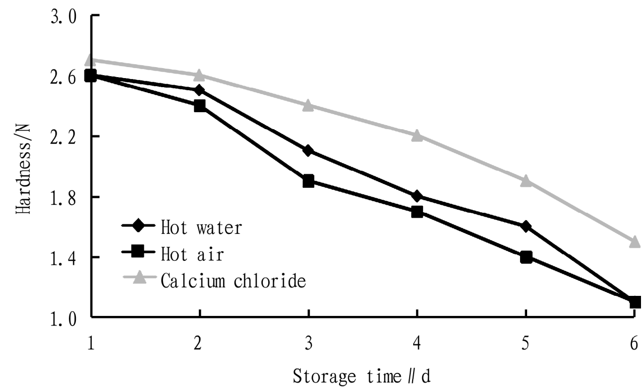

Fig. 2 Dynamics in hardness of strawberry fruit processed with different methods

3.4 Decay index As the storage time increased, the decay indices of the strawberries processed with hot water, hot air and calcium chloride increased continuously, and the upward trends were roughly the same. However, the decay index of the strawberries processed with hot water was smaller than those of the strawberries processed with hot air and calcium chloride (Fig. 3), suggesting that hot water processing can more delay the decay and maintain the quality of strawberry fruit.

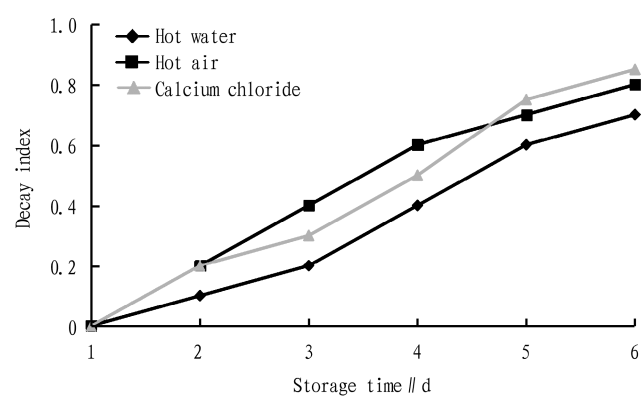

Fig. 3 Dynamics in decay index of strawberry fruit processed with different methods

3.5 Soluble solids content The soluble solids contents of the strawberries processed with hot water, hot air and calcium chloride all decreased within the 6 d, and the decreases were approximately similar. The content of soluble solids in the strawberries processed with hot water was higher than those in the strawberries processed with hot air and calcium chloride (Fig. 4), indicating that hot water processing can alleviate the decrease of the soluble solid content and maintain the quality of strawberry fruit.

3.6 Vc content Fig. 5 shows that the Vc contents of the strawberries processed with different methods all decreased within the 6 d, and the decreases were roughly similar. However, the content of Vc in the strawberries processed with hot water was higher than those of the strawberries processed with hot air and calcium chloride, indicating that hot water processing can alleviate the decrease in Vc content and maintain the edible value of commerciality of strawberries.

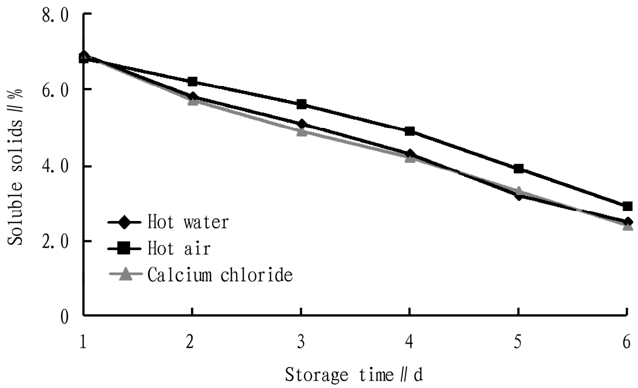

Fig.4 Dynamics in soluble solids content of strawberry fruit processed with different methods

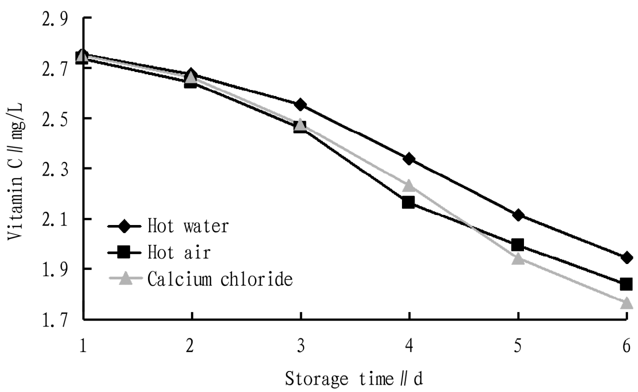

Fig.5 Dynamics in Vc content of strawberry fruit processed with different methods

4 Conclusions

Generally speaking, different processing methods of 45 ℃ hot water for 10 min, 45 ℃ hot air for 30 min and 3% calcium chloride for 1 min all can delay the decrease of hardness, Vc content and soluble solid content, inhibit weight loss rate and increase decay index of strawberry fruit, conducive to the storage and preservation of strawberries, maintaining the quality and ensuring the edibility and commerciality of strawberry fruit.

The results of this study show that the processing effect of 45 ℃ hot water for 10 min was better than that of 45 ℃ hot air for 30 min and 3% calcium chloride for 1 min. Hot water processing could prolong the time for strawberry fruit to begin to decay, obviously alleviate the increase in weight loss rate of strawberry fruit, and significantly alleviate the decrease of soluble solids and Vc contents of strawberry fruit. Although its ability to delay the decrease of strawberry fruit hardness was not as good as calcium chloride processing, considering comprehensively, the storage quality of strawberries proceed with 45 ℃ hot water for 10 min was the best. The overall effect of hot water processing was significantly better than that of hot air processing and calcium chloride processing. This may be because hot air and calcium chloride were not as effective as hot water in sterilizing and activating related resistant enzymes.

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Decorative Art of Doors and Windows in Southern Jiangxi: Taking Bailu Ancient Village as an Example

Yuting XIAO, Xiaoyun LI*, Yishun ZHOU

College of City Construction, Jiangxi Normal University, Nanchang 330022, China

Abstract China, as a country with 56 ethnic groups, has different geographical location, historical development and national customs. Residents in different places have incorporated different cultural characteristics when building local houses. This differentiated cultural and artistic feature is a reflection of the cultural connotation in a specific age and region. However, cultural protection is not always perfect. Many details are missed in this torrent of conservation culture, and door and window decorations are in this position. When collecting data, it is found that there is very little research on door and window decoration in Jiangxi. In this study, taking the doors and windows of Bailu Ancient Village as an example, combined with the cultural history of door and window decoration in southern Jiangxi, the artistic essence and historical value of the decorative patterns of houses were discussed. After searching a large number of documents, a field investigation was conducted in Bailu Ancient Village. Through direct observation of doors and windows and asking local residents about their understanding of door and window decoration, the history, current situation and future of door and window decoration in Bailu Ancient Village were described in detailed and predicted roughly.

Key words Bailu Ancient Village, Decorative art, Cultural significance, Realistic value

1 Introduction

Due to the rapid development of society and the instability and lack of culture, many people are terrified. Therefore, the continuous development of traditional ancient villages has turned more and more historical and cultural villages into tourist attractions. The traditional architectural elements and various intangible cultural heritages in the ancient villages are in a difficult situation under the pressure of modernization and interests. In many historical and cultural villages, due to inadequate protection measures, many traditional elements of the refurbished buildings are almost invisible. The rich historical information and cultural landscapes contained in traditional villages have disappeared. In 2012, the Expert Committee on the Protection and Development of Traditional Villages decided to change the customary title "ancient village" to "traditional village"[1]. Research and restoration of traditional villages in various places also started in an orderly manner. As of 2019, a total of five batches of the list of Chinese traditional villages have been published, with a total of 6 819, 343 of which are distributed in Jiangxi. Experts and scholars from various places have done detailed exploration and research on most traditional villages. The academic achievements on the decorative art of doors and windows in traditional villages are also very fruitful. Nevertheless, in order to better protect the cultural landscape and pass on civilization, a part of the ancient buildings in the ancient village, namely the doors and windows, were studied in this paper. Through the gaps between the doors and windows, the charm of the ancient architecture decoration was exhibited.

2 Overview of the architecture of Bailu Ancient Village

Bailu Ancient Village, which has been built more than 870 years ago, is located in the northernmost part of Ganxian District, Ganzhou City, Jiangxi Province. It is on the border of Ganxian County, and adjacent to Xingguo and Wan'an counties. The total area of the village is about 1 km^2, with a population of nearly 3 000 people. The village is an important education base for studying Hakka culture, religious culture, and ancestral temple culture in southern Jiangxi. Since Zhong's founding the foundation in the sixth year of the Shaw family in the Southern Song Dynasty, under the hard work of the ancestors, villagers in Bailu Ancient Village have cultivated a unique Hakka culture on the basis of inheriting the Central Plains culture. In the cultural tradition of Bailu Ancient village, the villagers usually go to business after farming well and enter the official carrier after doing business well. Therefore, the architecture of Bailu Ancient Village is different from the mainstream architectural style in southern Jiangxi[2]. It has Hakka dwellings, local dwellings and Huizhou dwellings, similar to the residential style in the middle reaches of the Ganjiang River. There are 45 ancient Ming and Qing buildings preserved in the village. The earliest one can be traced back to the end of the Ming Dynasty, and the latest one was built in the eighth year of the Republic of China (1919), most of which were built during the Qianlong, Jiaqing and Daoguang periods of the Qing Dynasty. The buildings in the village are mostly built around the mountains and rivers, and in the densely built part, the houses are

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Yuting XIAO, master, assistant planner, engaged in research of urban design. * Corresponding author. Xiaoyun LI, doctor, associate professor, engaged in research of urban design.
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