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Experiment on Different Storage Temperature Impact on Litchi's Quality Change

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Abstract

Experiments were conducted to investigate the close to freezing point (CFP) storage effect of litchis. The litchis are stored under two different kinds of storage conditions with different temperature. One part of the litchis is stored under CFP condition of which the temperature is -1.2℃ and the humidity is 87%, and the other part is stored under ordinary cold condition of which the temperature is 3℃ and the humidity is 87%. The quality of the litchis is detected periodically. The research results show that, after 35 days of CFP storage, litchi's amino acids content, has significantly increase, meanwhile VC, reducing sugar, acidity, water content and soluble solids content of litchi decreased much less than ordinary storage's. Therefore, the storage effect of litchi in CFP storage is more superior to that of ordinary cold storage.

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Keywords: litchi; close to freezing point (CFP) storage; freezing point; amino acids; vitamin C;

1. Introduction

Litchis, alias Dan Li, is a fruit of Sapindaceae Plants, originating in southern China, but most planted in Guangdong, Guangxi, Fujian, Sichuan, Taiwan, Yunnan et al. Litchis is rich in sugar with the role of add energy and increase nutrition, Litchis fruit also rich in vitamin C and protein. Litchis have the features of "after one day change colors, two days change aroma, three days change taste, after four days the color aroma and taste all disappear". Keeping Fresh relatively more difficult for litchi, but the most effective method of low temperature storage can solve this problem[1][2].

Advanced refrigeration technology and atmosphere storage technology can achieve longer storage and transportation purposes, but the cost is expensive, and has very short shelf life. Currently in China (especially in rural areas), that is difficult to promote. CFP storage, namely stored the food between 0℃ and their freezing temperature, is a non-frozen preservation, is the third generation of preservation technology following the cold storage and CA storage. The fundamental ideology of " CFP storage technology" is that: think the stored goods is a living body, under certain conditions, after the cooling

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treatment, storage products can achieve a similar "dormant" state, so that products in the "dormant" state preserved, then the minimum metabolic rate, the minimum energy consumption, which can effectively preserve the product quality and energy, and to achieve the longest life cycle. From study found that the key of decided to close to freezing point storage is to achieve products "dormant" state of the process. Achieve products "dormant" process is a cooling process. In the process, product through the adaptive adjustment, from the composition change within the histiocyte begin, to reduce their activity, reduce energy consumption, while ensuring their own characteristics of living life, it is a typical phenomenon of natural adaptation. CFP storage can effectively maintain fruits and vegetables' long-term natural flavor and fresh. CFP storage technology in Japan, Europe and the United States has been successfully used in agriculture, storage, animal husbandry, aquatic products 'storage and transportation and medical fields, it also obtain a wide range of results. Use of CFP storage, fruits and vegetables can reduce the metabolism, fruits and vegetables can be a long time to maintain the color, smell, taste and texture, fruits and vegetables in CFP storage is much better than ordinary storage. In this paper, with the help of Tianjin University of Commerce's high accuracy close to freezing point storage room, and advanced quality testing equipment, by comparing the experimental method, author test FeiZhixiao litchi's amino acids and other quality changes during close to freezing point storage process, looking for the relevance between the quality of litchi and environmental factors, in order to provide reference for litchi's close to freezing point storage technology in the future.

2. Test materials and methods

2.1 Test Materials

Litchi of FeiZhixiao purchased in Tianjin Han Shan Shu market In July 2009. It was transported to the Tianjin University of Commerce in the same day, and were cooled in 5 ℃ (± 1 ℃) in front room of CFP storage room.

2.2 Test environment and equipment

CFP storage experiment environment: using the cold device, which temperature fluctuation is ± 0.5 ℃, manufactured by Daqing Industrial Co., Ltd. of Japan in January 2007, the control group: using ordinary cold storage, which temperature fluctuation is ± 1.5 ℃, that made by Tianjin University of commerce. Major equipment for measuring freezing point included temperature instrument (MX100,Japan Ganges production), HPt100 thermal resistance, (A-level accuracy), the cold source (-15℃), second-class standard thermometer, vernier caliper, etc.

2.3 Experimental procedure and methods

(1) Select experimental subjects for freezing point measurement, freezing point were determined by freezing method.

(2) Cold acclimation for litchi before storage, cold acclimation process as follows:

$$5℃ \rightarrow 3℃ \xrightarrow{10h} 0℃ \xrightarrow{10h} -0.5℃ \xrightarrow{10h} -1.2℃.$$

(3) According to the measured freezing temperature to set the parameters of close to freezing point storage(CFP storage), litchi close to freezing point storage(CFP storage) temperature set to -1.2 ℃, the humidity is 87%, control group is 3 ℃ ordinary cold storage, the humidity is 87%.

(4) Sampling once every seven days for quality inspection. Free amino acids was determined by

refractometer(GRN1-WYA－2, ShangHai YiCe Equipment Co., Ltd.); titratable acid measured by acid-base titration; vitamin C content use 2,6 - dichlorophenolindophenol sodium titration; total sugar and reducing sugar was determined by fehling Thermal titration reagent.

3. Litchi determination of freezing point and storage temperature settings

Randomly select litchi to conduct the freezing point measurements. In general, fruit concentration at different positions is not the same and its freezing point is not the same, so measuring the freezing point should be measured in different positions[3], the highest point of the freezing point as the freezing point of litchi. Take four litchis, and insert the thermocouple temperature probe at different depths of litchi, insertion depth and the location of the freezing point in Table 1.

A temperature curve of litchi1 shown in Figure 3. According to figure 1, it is obvious that the freezing point near the core is the highest, from the center to the surface freezing temperature decreases, the center is the most prone to freezing, so, the freezing temperature of litchi is the temperature near the core, it is -2.2℃.

Considering temperature fluctuations and safety redundancy, storage temperature should be set slightly higher than the freezing temperature. Under normal circumstances:

Storage temperature = Freezing temperature + Temperature fluctuations + Safety redundancy

Table.1 Freezing point and the depth of thermocouple insert in litchi

Serial number	fruit	position	Freezing point/℃
1		Near the core	-2.2
2		From the nuclear 1 / 2	-2.4
3	litchi 1	Near the epidermis	-3.1
4		Near the core	-2.3
5		From the nuclear 1 / 2	-2.5
6	litchi 2	Near the epidermis	-3.5
7		Near the core	-2.2
8		From the nuclear 1 / 2	-2.5
9	litchi 3	Near the epidermis	-3.1
10		Near the core	-2.2
11		From the nuclear 1 / 2	-2.4
12	litchi 4	Near the epidermis	-2.8

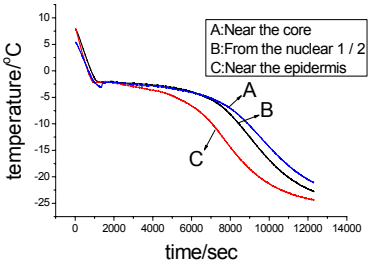


Fig.1 Freezing curve of litchi 1

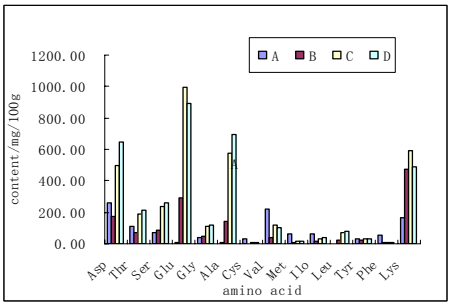
In this study, litchi freezing point is -2.2 ℃, temperature fluctuations set to 0.4 ℃, safety redundancy set to 0.6℃. Therefore litchi CFP storage temperature should be -1.2 ℃,and the humidity is 87%, the control group set to 3 ℃ in ordinary storage, and the humidity is 87%.

4. Results and discussion

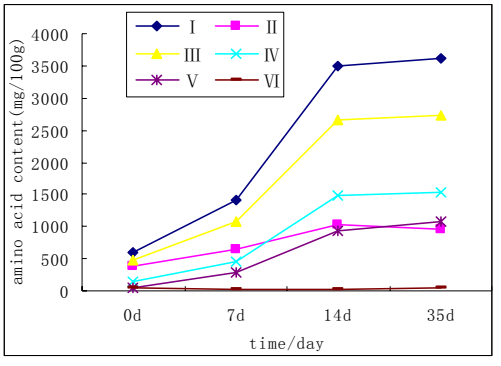
4.1 Different storage temperature impact on amino acid content of litchi

Storage temperature greater impact on the amino acid content. Figure 2, Figure 3 shows that litchi fruit to alanine (Ala), glutamate (Glu), lysine (Lys), aspartic acid (Asp) and threonine (Thr) as the main amino acids[4], the total of which is more than the total of amino acid content's 76.68%.

Near the temperature of freezing point, in order to prevent formation of ice crystals, litchi continuously produces large amounts of ice-free solution (glucose, amino acids, aspartic acid, etc.) to lower the freezing point. This moment the water-soluble molecules release by biological cells cut off the protein, which will be released as amino acids[4][5] so under the CFP storage conditions, amino acids will increased. During -1.2℃ storage, total amino acid content of litchi as high as 3.61g/100g, is 3.2 times the 3℃storage. Essential amino acids (Lie, Leu, Lys, Thr, Val, Phe, Met) content, increased gradually, in the first 7 days is total amino acid content's 45.2% and after 35 days storage is 2.5 times the initial value. Sweet amino acids (Ala, Gly, Ser), and delicious amino acids (Glu, Asp), during 35 days storage, also increased significantly. Clearly to see that CFP storage technology can effectively increased amino acid content.



A: 3℃ storage for 10 days; B: -1.2℃ storage for 7 days, C: -1.2℃ storage for 14 days, D: -1.2℃ storage for 35 days
Fig.2 The effect of different storage temperature on litchi's amino acid content



Ⅰ:Total amino acids, Ⅱ: Essential amino acids; Ⅲ: Major amino acids; Ⅳ: Flavor amino acids; Ⅴ: Sweet taste of amino acids, Ⅵ: Aromatic amino acids
Fig.3 The main amino acid content in CFP storage

4.2 Different storage temperature impact on litchi's acidity, water content and soluble solids.

Acidity is a very important quality indicator for litchi. In the mature period, acidity reduction is the key of good taste change and also the main reasons of shorten shelf life[6]. During 35 days storaged, water content, acidity and soluble solids of litchi, which stored in two diferent kinds of storage condition,have been measured, every 7days. The experimental results show by Figure 4, Figure 5 and Figure 6.

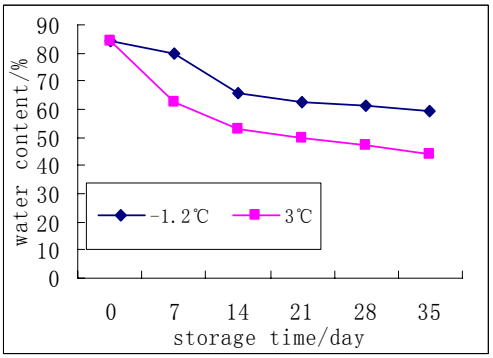


Fig.4 The effect of different storage temperature on litchi's water content

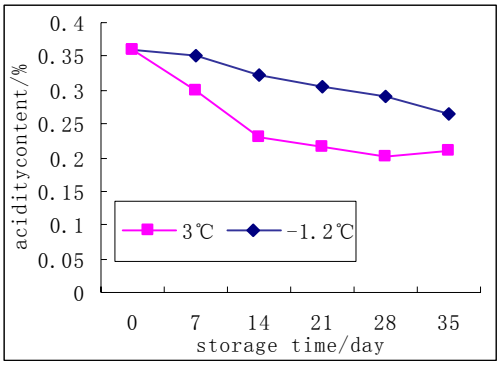


Fig.5 The effect of different storage temperature on litchi's acidity

Litchi as a non-respiratory peak fruit[6], due to metabolically active after picking, it will consume large amounts of nutrients. Figure 5 show, during storage at 3 ℃, litchi acid content of pulp has been below the -1.2℃ storage's. The first 30 days, acid content decreased 1.5% than initial value, 55.3% reduction. But during the -1.2℃ storage， the pulp acid content decreased, in the 35 days the acid content decreased to 1.09%, 30.2% reduction.

Figure 6 shows that, litchi at 3℃storage and -1.2℃ storage period, due to consumption of nutrients, the amount of soluble solids decreased gradually, but at the first 7 to 14days, which decreased rapidly. 35 days later stored at 3 ℃, soluble solid content decreased to 9.81%. However at 1.2℃ storage, soluble solids decreased 2.22% compared with initial value. This shows a better storage performance of litchi, the lower the temperature, the more inhibited the respiration of litchi.

4.3 Different storage temperature impact on Litchi's vitamin C and sugar content.

Litchi as a non-respiratory peak fruit, after harvesting, reserve material in the litchi will not be hydrolysis, respiration mainly use of soluble sugars.

respiration is greatly decreased[7], with the storage time it was decreased gradually. Due to metabolically active after picking, it will consume large amounts of nutrients, so the fruit reducing sugar and vitamin C content decreased rapidly.

From Figure 7 we can see the lower temperature of the pulp, the more influenced VC content. At 3 ℃storage, VC content has been below -1.2℃storage's. Stored at 3℃, VC content of litchi has been decreasing, especially at post-storage VC content went down quickly. While at the 35 days VC content reduced to 18.72mg/100g, only 27.5% of initial value. But storage at -1.2℃ VC content of attrition is relatively high in the pre-storage, While in the Post-storage went down slowly. At the 35 days, VC content of litchi, which stored at -1.2℃, equal to the content of 3℃ storage for 14 days, is 58.82% of the initial value. Therefore, seen from the above that CFP storage can effectively preserve the content of litchi VC.

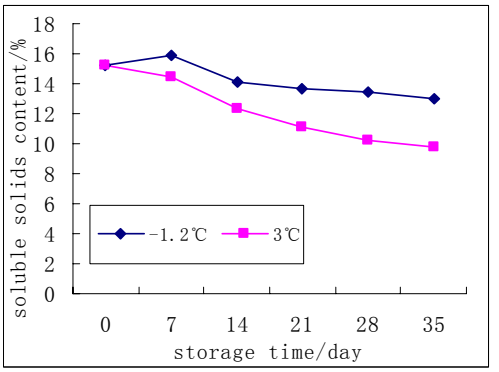


Fig.6 The effect of different storage temperature of on litchi's soluble solids

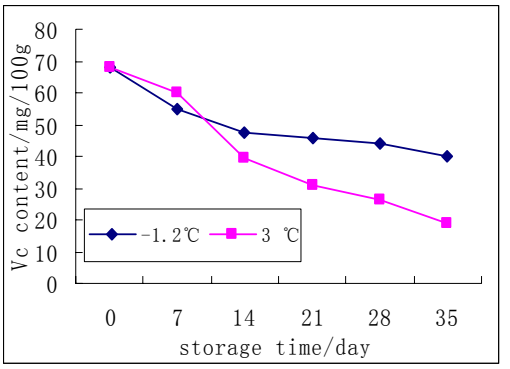


Fig.7 The effect of different storage temperature on litchi's VC

Figure 8 shows that during the first 10 days of storage, The reducing sugar content of litchi in 3 ℃ storage is more than -1.2℃ storage, that is due to the experimental litchi is the seven or eight mature, and ordinary storage temperature is relatively high， which is beneficial for litchi, during storage, keep a high level of carbohydrate metabolism, therefore, Synthesized more reducing sugars (monosaccharide and disaccharides). After 14 days, the reducing sugar content decreased. At the 35 days, the reducing sugar content of litchi, which stored at 3℃, dropped to 4.8%, while in the -1.2℃ storage only down to 11%. Under CFP storage conditions carbohydrate metabolism was slow, so it is obviously to see that the CFP storage can effectively reduce the consumption of carbohydrates.

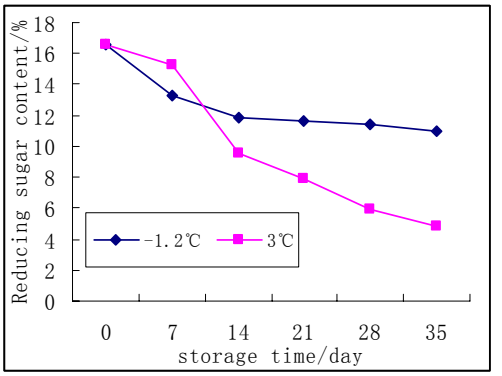


Fig.8 The effect of different storage temperature on litchi's reducing sugar contents

5. Conclusion

Through the 35 days experimental study on litchi, it is obvious to see that, compared with the 3℃ storage, the CFP storage much better than 3℃ storage. During CFP storage litchi's amino acids content has significantly increase, and whose acidity, water content, VC, reducing sugar and soluble solids content change significantly smaller. The study result shows that CFP storage technique can effectively preserve the litchi's quality and energy, and to achieve the longest life cycle, this has potentially significant implications to the long term storage of litchi, and perhaps other vegetables and fruits.

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