Effects of Different Treatments on White-blush of Fresh-cut Carrots During Storage

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Abstract: In order to screen out the preservatives that had better effects on inhibiting the white-blush of fresh-cut carrots, prolong its shelf life. Using fresh carrots as the test material, the effects of different treatments on the white-blush of fresh-cut carrots during storage were compared, and the changes in whiteness value of fresh-cut carrots in each group were analyzed. Other relevant physical and chemical indicators were measured. The results showed that compared with other treatment groups, the onion treatment group had the lowest whiteness index, the strongest antioxidant capacity, and the best quality of fresh-cut carrots. This indicated that onions were suitable for processing fresh-cut carrots, which cold better inhibit the activities of POD, PAL, and other enzymes, inhibit the white-blush of fresh-cut carrots, and delay their aging.

1 INTRODUCTION

Fresh-cut carrots, due to dehydration and lignification during storage, lead to whiteness on the surface, losing the characteristic bright yellow, limiting carrot development. Therefore, it is necessary to inhibit the white-blush of fresh-cut carrots and extend their shelf life.

There have also been some reports on the preservation of fresh-cut carrots and the correlation of their whitening control. Ren, L.F's (2014) research showed that 0.6% citric acid and 0.4% ascorbic acid had the best effect on reducing the whiteness value of fresh cut carrots. Chen Chen et al. (2018) reported in their research that treating fresh cut carrots with H_2S could significantly inhibit their whitening, reduce the activity of lignin synthesis related enzymes (PAL, PPO, POD), and improve the antioxidant ability of fresh cut carrots. However, the application of biological preservatives such as natural plant extract and bioantagonistic bacteria in fresh-cut carrots has not been reported. Onions contain a large number of sulfur compounds, mainly disulfides and trictrulfides. A research [9] that showed that disulfides and triculfides could inhibit the enzyme activities of PPO and POD in fruits and vegetables, which provides a theoretical basis for onion juice to inhibit the white-blush of fresh-cut carrots.

In this experiment, fresh-cut carrots were treated with citric acid, ascorbic acid, hydrogen sulfide (donor: sodium hydrosulfide), and onion juice, with water cleaning group as a control group. The changes in whiteness values during storage in each group were analyzed, and relevant physiological and biochemical indicators were measured to explore the inhibitory effect of onion juice on the white-blush of fresh-cut carrots and select the best preservative for the blanching inhibition of fresh-cut carrots.

2 MATERIALS AND INSTRUMENTS

2.1 Main Materials

Carrots, buy on market; onion, buy on market.

2.1.1 Main Reagent

Citric acid, ascorbic acid, hydrogen sulfide, analytical pure, Tianjin Guangfu Fine Chemical Research Institute; petroleum ether, acetone, sulfuric acid, analytical pure, Tianjin Kaitong Chemical Reagent Co., Ltd.

2.1.2 Main Instruments

CM-700d spectrolight colorometer, Konica Minolta; HH-S constant temperature water bath, Changzhou Fengtian; H1850R desktop high-speed refrigerated centrifuge, Xiangyi; ISO9001 electronic balance, Sidis; BCD-288 WSL refrigerator, Haier, Qingdao.

2.2 Experimental Methods

2.2.1 The Processing of the Samples

(1) Select fresh, pest-free, uniform size and quality carrots, peel and cut them into 2 cm thick pieces, clean with water, drain and set aside.

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(2) Preparation of onion juice: In a sterile environment, peel and cut onions into pieces, place them in a juicer to extract juice, use sterilized four layers of gauze to aseptically filter on an ultra clean workbench to obtain a 100% concentration of onion stock solution, then dilute the stock solution with deionized water to a concentration of 75%, store at 4℃.

(3) Fresh-cut carrots were treated with citric acid, ascorbic acid, hydrogen sulfide (donor: sodium hydrosulfide), and onion juice. The water washing group was used as a control group, and stored at 4℃. Their physiological and biochemical indexes and whiteness values were measured on 1, 3, 5, 7 and 9 day, respectively, to analyze the changes in their whiteness value and physiological and biochemical indexes.

Table 1: Different treatment reagents and their potency

reagents	citric acid	ascorbic acid	sodium bisulfide	Onion juice	CK
potency	0.60%	0.40%	0.4 m M	75%	

2.2.2 Determination of the Whiteness Value

Refer to the method of Bolin et al. (1991) for measurement. Whiteness index (Wi) was calculated as the follows:

$$Wi = 100 - \sqrt{(100 - L)^2 + a^2 + b^2}$$

2.2.3 Measurement of Phenylalanine Lylyase (PAL)

Refer to the method of Sun (2002) for measurement.

2.2.4 Measurement of Peroxidase (POD)

The guaiacol method (Li, 2002) was used for determination.

2.2.5 Determination of the Carotenoids

Refer to the method of Fan (2011) for determination.

2.2.6 The DPPH Free Radical Clearance Rate

Refer to the method of Chen et al (2016) for measurement.

2.2.7 Data Processing

Each group of samples was measured three times in parallel, and the data obtained were analyzed and processed by Origin8.5 software, and the Duncan method was used for multiple comparisons of difference significance. Those marked with different letters indicated significant differences between groups(P<0.05), while those marked with the same lowercase letters indicated insignificant differences between groups(P>0.05).

3 RESULTS AND ANALYSIS

3.1 Effect of different treatments on the whiteness values of fresh-cut carrots

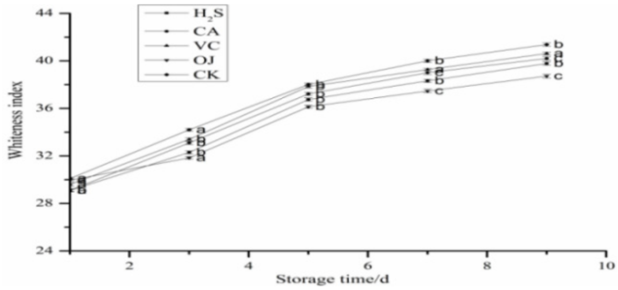

Fig 1: Effect of different treatments on the whitening values of freshly cut carrots

Table 2: Significant analysis of the difference in whiteness values between different groups

process mode	White value
H_2S	10.84 ± 0.148c
citric acid	11.04 ± 0.067bc
ascorbic acid	11.18 ± 0.148ab
Onion juice	8.92 ± 0.136d
control group	11.36 ± 0.145a

Fig 1 showed that the whiteness values of fresh- cut carrots increased gradually throughout the storage period. Table 1 was the difference between the group the first day and 9 day, from table 1, the difference between the onion juice treatment group and each group was significant (P <0.05), compared with the other group during the storage, indicating that the onion juice treatment was best, and could better suppress the whitening of fresh-cut carrots.

3.2 Effect of different treatments on PAL enzyme activity during storage of fresh-cut carrots

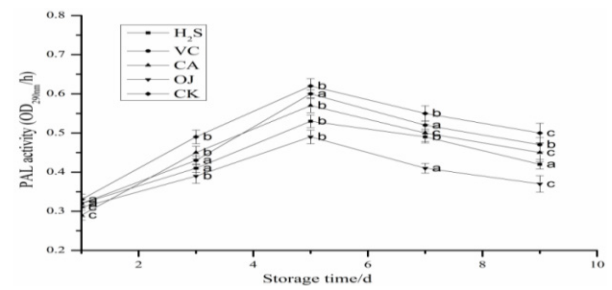

Fig 2: Effect of different treatments on PAL enzyme activity of fresh-cut carrots

Table 3: Significance analysis of PAL difference between different groups

process mode	PAL
H_2S	0.110 ± 0.010c
citric acid	0.147 ± 0.020b
ascorbic acid	0.170 ± 0.015ab
Onion juice	0.073 ± 0.021d
control group	0.193 ± 0.020a

From Fig 2, PAL activity increased first and then decreased during storage. Table 2 showed the significant analysis of the difference between the first day and 9 day of the groups. From table 2, it showed that the difference between the onion treatment group and the other groups was significant ($P < 0.05$). As could be seen from Fig 2, the PAL activity of onion treated group was low during storage, indicating that onion treated fresh-cut carrots could better inhibit its PAL enzyme activity. Therefore, onion juice was more suitable for processing fresh-cut carrots from the perspective of reducing PAL activity.

3.3 Effect of different treatments on POD enzyme activity during storage of fresh-cut carrots

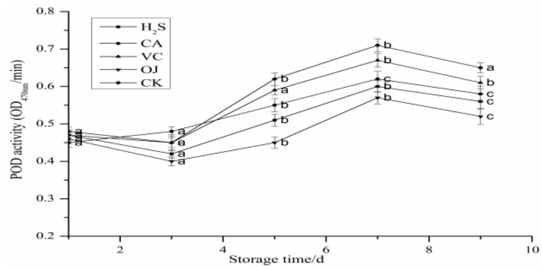

Fig 3: Effects of different treatments on the POD activity of fresh-cut carrots

Table 4: Significance analysis of differences in POD among different groups

process mode	POD
H_2S	0.100 ± 0.010c
citric acid	0.137 ± 0.012b
ascorbic acid	0.153 ± 0.021b
Onion juice	0.073 ± 0.015d
control group	0.193 ± 0.015a

From Fig 3, the PPO enzyme activity of fresh-cut carrots increased first and then decreased during the whole storage period. Table 3 was an analysis of the difference between the first day and 9 day of each group. From table 3, it showed that the difference between the onion treatment group and the other groups was significant ($P < 0.05$). As could been seen from Fig 3, the onion treatment group had low POD activity during storage, and with POD activity as the reference indicator, onion juice was more suitable for treating the fresh-cut carrots.

3.4 Effect of different treatments on carotenoid content during storage of fresh-cut carrots

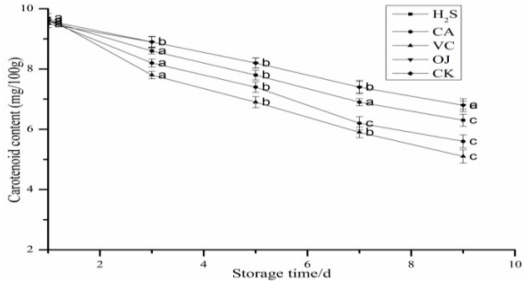

Fig 4: The effect of different treatments on the carotenoid content of fresh-cut carrots

Table 5: Significance analysis of differences in carotenoid among different groups

process mode	carotenoid
H_2S	3.53 ± 0.252c
citric acid	4.23 ± 0.252b
ascorbic acid	4.77 ± 0.153a
Onion juice	2.83 ± 0.153d
control group	5.03 ± 0.208a

According to Fig 4, the carotenoid content of fresh-cut carrots showed a downward trend during storage. Table 4 was the significant analysis of the difference between the first day and 9 day, from table 4, there were significant differences($P < 0.05$) between the control group and the ascorbic acid treatment group and other groups. From Fig 4, it could been seen that the carotenoid content of fresh-cut carrots treated with onions decreased slowly during storage. Taking carotenoids as a reference index, onion treated fresh cut carrots had better effect, more suitable for processing fresh cut carrots.

3.5 Effect of different treatments on DPPH during storage of fresh-cut carrots

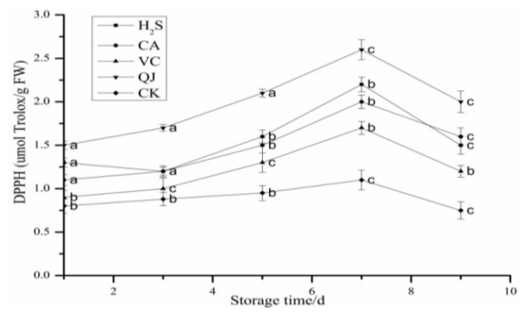

Fig5: The effect of different treatments on DPPH of fresh-cut carrots

Table 6: Significance analysis of the difference in DPPH between different groups

process mode	DPPH
H_2S	0.433 ± 0.208bc
citric acid	0.390 ± 0.101c
ascorbic acid	0.367 ± 0.058c
Onion juice	0.633 ± 0.115ab
control group	0.083 ± 0.029d

According to Fig 5, DPPH tended to increase first and then decrease during storage. Table 5 was an analysis of the significance of the difference between the first day and 9 day of each group. Table 5 showed there were significant($P < 0.05$) differences between the onion treatment group and other groups. As could be seen from Fig 5, DPPH in onion juice treated group was consistently higher, indicating that onion juice was more suitable for treating fresh-cut carrots and the effect was optimal.

4 CONCLUSION

Onion is a vegetable belonging to the genus Allium in the lily family, known as the "Queen of Vegetables" (Sun, et al. 2012), Because of its high nutritional composition. The active substances in onion include sulfur compounds [10], Kaempferol, caffeic acid, lauric acid, mustard acid, quercetin and other substances [5]. The volatile oil is rich in ingredients, mainly alliin, thiol, dimethyl disulfide, trichiulfide, etc. Onions also have some other functions, such as anti-inflammatory and bacteriostatic, preventing hypertension, improving immunity, and reducing blood sugar [11].

In this experiment, citric acid, ascorbic acid, H_2S, and onion juice were used as treatment groups to treat fresh-cut carrots, while those washed with clean water were used as control groups. After storage at 4℃ , compare the change of physiological and biochemical indicators, whiteness value as the main index, other indicators for reference, found that the quality of fresh-cut carrots treated with onion was best, the effect of inhibiting the white-blush of fresh-cut carrots was the best, and the antioxidant capacity was the strongest. This indicates that onion juice is more suitable for processing fresh-cut carrots, better inhibiting the activities of POD, PAL, and other enzymes, delaying their aging, and extending their shelf life. Onion juice is also a natural extract with non-toxic, harmless, and natural characteristics, which are unparalleled advantages of chemical preservatives such as citric acid, ascorbic acid, and H_2S. Compared with chemical reagents, onion juice has the characteristics of natural, non-toxic and harmless, which opens up a new way to control the white-blush of fresh-cut carrots, and lays a foundation for the control of the white-blush of fresh-cut carrots by natural extracts in the future.

REFERENCES

1 Bolin, H.R., Huxsoll, C.C. (1991) Effect of preparation procedures and storage parameters on quality retention of salad-cut lettuce. Journal of Food Science, 56(1): 60-62.

2 Chen, C., Hu, W.Z., Zhang, R.D., et al. (2018) Effects of hydrogen sulfide on the surface whitening and physiological responses of fresh-cut carrots. Journal of the science of food and agriculture, 98(12): 4726-4732.

3 Chen, C., Hu, W.Z., Zhang, R.D., et al. (2016) Levels of phenolic compounds, antioxidant capacity, and microbial counts of fresh-cut onions after treatment with a combination of nisin and citric acid. Horticulture , Environment , and Biotechnology, 57(3): 266-273.

4 Fan, T. (2011) Study on Whitening and Coating Control of Fresh-cut Carrots. Shandong Agricultural University, Shandong.

5 Liu Jintao, Zhao Ping, Lin Yuling, et al. Effect of fermentation on thiol compounds in crude extract of red onion skin and its antibacterial properties [J]. Bio-Resources, 2020, (001): 97-102.

6 Li Hesheng. Modern Plant Physiology [M] Beijing: Higher Education Press, 2002,2:415-420..

7 Ren, L.F. (2014) Research on quality change and preservation technology of fresh cut carrots during storage. Hebei Normal University of Science and Technology, Hebei.

8 Sun, G.Y., Zong, Z.F. (2002) Experimental techniques of plant pathology. Beijing: China Agricultural Press, 116-118.

9 Wang, Z.H. (2007) Extraction and preservation effect and analysis of essential oil of onion. Huazhong Agricultural University, Hubei.

10 Willian, H.B., John, D.F., Hashim, E.O., et al. (2001). Administration of Raw Onion Inhibits Platelet-Mediated Thrombosis in Dogs. The Journal of Nutrition , 131(10): 2619-2622.

11 Wang, Q., Cao, A.L., Wang, P., et al. (2001) Extraction value of onion oil and its technique. Food Science, 22 (8): 56-58.

12 Zhu, G.L. (1990) Plant physiology experiments. Beijing: Peking University Press,.