Effects of Spraying Calcium Nitrate and NAA on the Storage Quality of Figs “Bo JiHong”

Xiaoai Zhang1, *Yang Liu2, Liping LIU3, Xingteng Wang4, Weixin Wang5, Yuerong Liu6, Qunxian Deng7, Huifen Zhang8, Xun Wang9, Hui Xia10 and Dong Liang11

1College of Horticulture, Sichuan Agricultural University,China
2College of Horticulture, Sichuan Agricultural University,China
3College of Horticulture, Sichuan Agricultural University,China
4College of Horticulture, Sichuan Agricultural University,China
5College of Horticulture, Sichuan Agricultural University,China
6College of Horticulture, Sichuan Agricultural University,China
7College of Horticulture, Sichuan Agricultural University,China
8College of Horticulture, Sichuan Agricultural University,China
9College of Horticulture, Sichuan Agricultural University,China
10College of Horticulture, Sichuan Agricultural University,China
11College of Horticulture, Sichuan Agricultural University,China

Abstract: This study aimed to improve the storage quality of figs by determining how spraying calcium nitrate on fig fruits and naphthaleneacetic acid (NAA) on leaves before plucking the fruits affect their storage quality. Storage experiments were performed on 4-year-old Bo JiHong, and results showed that all treatments contributed to improving the fruits’ hardness and alleviating the changes in several factors, including fruit-rot rate, soluble solids, titratable acid, and vitamin C content. In particular, the change rates of these factors for the calcium-alone treatment group decreased by 0%–15%, 6.2%–27.1%, 13.4%–32.4%, and 29.5%–31.3%, respectively, compared with the control group. Meanwhile, the change rates for the calcium + NAA treatment group decreased by 55%–70%, 34.7%–50.7%, 27.8%–54.8%, and 35.2%–60%, respectively, compared with the control group. These findings indicated that the consumption of nutrients inside the fruits was greatly diminished, the fruit shape was maintained, and the storage quality of figs was enhanced. The optimal storage effect was achieved by applying 0.5% Ca(NO3)2 + 30 mg·L−1 NAA.

1. Introduction

Fig (Ficus carica Linn.), a genus of Sanko, is a subtropical deciduous tree; it contains various sugars, citric acid, and malic acid; it has rich nutritional value and is widely used in medical and health, industrial production, and food processing; it has a good application prospect and high economic value [1, 2]. However, the fig is easy to rot and deteriorate, it is hard to storage and transportation because of its thin peel and fleshy fruit. Thus, it is essential to improve the fresh fruit storage and
preservation technology of Fig. Therefore, the study of preharvest processing technology to improve the quality of fig storage has an important effect on the improvement and systemization of storage technology [3].

At present, preharvest calcium technology has been applied in the storage of various fresh fruits, such as apples, oligofruits, nectarines, strawberries, guava, and peaches [4–6]; this technology can significantly improve the storage quality of fresh fruits. Calcium treatment can prolong the storage period of strawberries and increase the ratio of sugar to acid in fruits. This treatment also can increase the activity of superoxide dismutase in kiwifruit, thereby reducing respiration and ethylene production [7, 8].

Naphthaleneacetic acid (NAA) promotes the action of spermidine in kiwifruit, which can significantly delay the softening and senescence of kiwifruit. NAA can also delay the ripening of potatoes and inhibit the production of ethylene [9, 10]. Calcium and NAA technology is not widely used in figs.

In this experiment, four-year, cold-tolerant, and alkali-resistant “Bao Jihong” variety figs were used as test materials. “Pujihong” has summer and autumn fruit, bright skin color, light red or red inside the flesh, good quality, minimal pests and diseases, strong adaptability, easy cultivation, and high yield [11]. The effects of preharvest calcium and NAA on the storage quality of figs were discussed. The aim was to provide a reference for improving the storage quality of figs and a theoretical basis for the storage and preservation technology of fig fruits.

2. Materials and Methods

2.1 Test materials
The 4 year-old variety was “F. carica Linn,” with no mechanical damage, pests, and diseases, and figs of uniform size were used as test materials. The fruit of the variety gradually matured in late June, and 15 plants were selected. The plants had a height of 1.5–2.0 m, plant spacing of 1.5 m × 2 m, good growth and development, plexiform plastic cultivation, and fine management.

The test reagents were Ca(NO₃)₂, NAA, iodine solution, H₂SO₄, NaOH, and alcohol, supplied by Ruijin Biopharmaceutical Company.

2.2 Test methods

2.2.1 Test design
Experimental design: Fifteen plants with the same growth conditions were randomly selected from the Chongzhou fig planting base. Each group of three plants was treated once, and a total of five groups were treated to determine the optimal test results.

Different treatments: Distilled water and calcium nitrate were used to prepare calcium nitrate solution [12], naphthalene acetic acid was formulated into a solution of 30 mg · L⁻¹ [13], and the two solutions were charged into the spraying device; the specific treatment was as follows

| Numbering | Test treatment                                      |
|-----------|----------------------------------------------------|
| 1         | 0.5% Ca(NO₃)₂ spraying fruit;                      |
| 2         | 1.0% Ca(NO₃)₂ spraying fruit;                       |
| 3         | 0.5% Ca(NO₃)₂ spraying fruit + 30 mg · L⁻¹ NAA spraying blade |
| 4         | 1.0% Ca(NO₃)₂ spraying fruit + 30 mg · L⁻¹ NAA spraying blade |
| CK        | Clear water (control)                              |

Test treatment: Calcium nitrate treatment of fig fruit and NAA treatment of leaves were conducted. When spraying, the distance was close, and the range of motion was small. A baffle was used to
prevent other organs of the plant from being sprayed with the treatment solution. Treatment was performed once for each of the three stages of fruit development. The three periods were rapid growth periods, the fruit was acquired after 30–40 days, the fruit rapidly expanded, and the sugar content of the fruit continued to increase. During the fruit color change period, the fruit was harvested after 50–60 days, its color changed, the fruit sweetness increased, and the sugar gradually accumulated. The fruit was harvested from 60 days to 65 days, and the fruit had the best hardness, color, and flavor.

Fruit picking: All processed fruits were harvested in mid-June, each plant had no less than 10 fruits, and the number of fruits collected per plant was not less than 40. The test fruit bag was treated, perforated, and stored in a refrigerator at 1 °C [14]. The intrinsic and extrinsic qualities of the fruit were determined.

Data measurement: On the 0th, 3rd, 6th, 12th, and 15th day after regular postharvest storage, the intrinsic and extrinsic qualities were determined by taking samples from each treated polyethylene bag. The total number of fruit in the external quality bagging was unchanged, and the process was repeated 3 times [15].

2.2.2 Determination of items and methods

| Measurement item                  | Measurement index | Determination method                           |
|-----------------------------------|-------------------|-----------------------------------------------|
| Determination of the external     | Rot rate (%)      | (Number of rotted fruit / total number of     |
| quality of the fruit              |                   | fruits) × 100%                                |
|                                   | Weight-loss rate  | (Difference between mass measured by balance   |
|                                   | (%)               | and initial mass / initial mass) × 100%        |
|                                   | Fruit hardness    | Hardness measurement should be applied to the  |
| test                               |                   | intrinsic quality of the bagged fig           |
| Determination of intrinsic        | Soluble solids (%)| Refractometer determination                    |
| quality of fruit                   |                   |                                               |
|                                   | Titrate acid (%)  | by acid-base titration                        |
|                                   |                   |                                               |
|                                   | Determination of  | by iodine titration                            |
|                                   | vitamin C content |                                               |
|                                   | Soluble sugar (%) | Fluorenone colorimetric determination[16, 17]  |

2.3 Data statistics and analysis
Data collation and analysis were performed using Excel 2010 and DPS.

3. Analysis of Test Results

3.1 Determination of the external quality of the fruit

3.1.1 Effects of different treatments on fruit-rot rate and weight-loss rate
With prolonged storage time, the fruit-rot rate gradually increased and the fruit-rot rate was the fastest on the 9th–12th day (Table 3). After 15 days of treatment with 0.5% Ca(NO₃)₂ and the control group, the fruits were all rotted after 15 days of storage. Most of the fruits treated with 1% Ca(NO₃)₂ had rotted, 0.5% Ca(NO₃)₂ + 30 mg·L⁻¹. The final fruit-rot rates for NAA and 1% Ca(NO₃)₂ + 30 mg·L⁻¹
NAA treatments were less than 50%, and 0.5%, respectively. Thus, \(\text{Ca(NO}_3\text{)}_2 + 30 \text{ mg·L}^{-1}\) NAA treatment can reduce the rot rate and maintain the fruit shape. Overall, the effect of calcium + naphthalene acetic acid was significant.

Table 3 presents that the difference in the effect of calcium and naphthalene acetic acid on the weight-loss rate of the fruit was insignificant. The difference in weight-loss rate of each treatment was insignificant, and the weight-loss rate of 0.5% \(\text{Ca(NO}_3\text{)}_2\) treatment was 3.9%.

Table 3. Changes in weight-loss rate and fruit-rot rate during storage with different treatments

| Treatment                  | 3 days after storage | 6 days after storage | 9 days after storage | 12 days after storage | 15 days after storage |
|----------------------------|----------------------|----------------------|----------------------|-----------------------|-----------------------|
|                            | weight loss rate     | fruit rot rate       | weight loss rate     | fruit rot rate        | weight loss rate      | fruit rot rate       |
|                            | %                    | %                    | %                    | %                     | %                    | %                    |
| 0.5% \(\text{Ca(NO}_3\text{)}_2\) | 0                    | 0                    | 0.1                  | 20                    | 1.7                  | 50                   | 3.5                  | 85                   | 3.9                  | 100                  |
| 1% \(\text{Ca(NO}_3\text{)}_2\)   | 0.3                  | 0                    | 0.3                  | 15                    | 1.1                  | 25                   | 2.8                  | 60                   | 3.5                  | 85                   |
| 0.5% \(\text{Ca(NO}_3\text{)}_2\) + 30 mg·L\(^{-1}\) NAA | 0                    | 0.1                  | 0                    | 1.4                   | 5                    | 3.1                  | 15                   | 3.5                  | 30                   |
| 1% \(\text{Ca(NO}_3\text{)}_2\) + 30 mg·L\(^{-1}\) NAA | 0                    | 0                    | 0                    | 1.6                   | 10                   | 2.5                  | 35                   | 3                    | 45                   |
| \(\text{NAA}\) | 0.2                  | 5                    | 0.4                  | 15                    | 1.7                  | 45                   | 3                    | 90                   | 3                    | 100                  |

3.1.2 Effects of different treatments on fig hardness and appearance evaluation

Table 4 shows that calcium exerted an enhanced effect on the hardness of fruit after harvesting. The combination of calcium and naphthalene acetic acid exhibited a significant effect on the increase in fruit firmness because calcium promoted the formation of cell wall. After storage for 15 days, the hardness of the fruit with 0.5% \(\text{Ca(NO}_3\text{)}_2 + 30 \text{ mg·L}^{-1}\) NAA and 0.5% \(\text{Ca(NO}_3\text{)}_2 + 30 \text{ mg·L}^{-1}\) NAA was significantly better than that of other groups. Calcium and NAA effectively maintained the hardness of the fruit; only under the influence of calcium nitrate, the effect was insignificant.

Table 4. Evaluation of fruit hardness and appearance after storage during different treatments

| Treatment                  | Fruit hardness | Fruit appearance evaluation |
|----------------------------|----------------|-----------------------------|
| Before storage             |                | No good fruit; the fruit texture is soft, is non-yellow, has decayed, and has a strong taste. |
| After storage              | ++             | A few fruits look good, cyan, and soft. |
| Before storage             | +              | A few have deepened reddish color, the overall texture is good, and the fruit partially rots. |
| After storage              | +              | The fruit color is slightly lighter than that of the upper group, the color of the fruit is red, and the maturity is higher than that of the upper group. |
| Before storage             | +              | No good fruit; the fruit texture is soft, the color is mainly cyan, and the fruit has minor and modest taste. |
| After storage              | ++             | No good fruit; the fruit texture is soft, the color is mainly cyan, and the fruit has minor and modest taste. |

Note: The hardness of each column is divided into the following six levels: hard (+ + +) fruit hardness > 5, harder (+ +) fruit hardness 5–4, slightly hard (+) fruit hardness 4–3, slightly softer (−) fruit hardness 3–2, softer (−−) fruit hardness 2–1, soft (−−−) fruit hardness <1.
3.2 Determination of the intrinsic quality of the fruit

3.2.1 Effects of different treatments on the content of soluble solids in fig fruit

Table 5 Differences in intrinsic quality indicators at different harvesting treatments

| Treatment                  | Soluble solid content (%) | Titratable acid content (%) | Vitamin C content (mg·100g⁻¹) | Soluble sugar content (%) |
|----------------------------|----------------------------|----------------------------|-------------------------------|--------------------------|
| 0.5% Ca(NO₃)₂             | 13.4b                      | 0.25b                      | 5.4c                          | 12.3b                    |
| 1% Ca(NO₃)₂               | 13.9a                      | 0.26a                      | 5.2b                          | 12.7b                    |
| 0.5% Ca(NO₃)₂ + 30 mg·L⁻¹ NAA | 12.6a                     | 0.16a                      | 5.4a                          | 18.5c                    |
| 1% Ca(NO₃)₂ + 30 mg·L⁻¹ NAA | 11.6c                     | 0.15c                      | 4.0b                          | 18.4c                    |
| Control (CK)              | 15.1a                      | 0.25a                      | 4.7b                          | 14.4b                    |

Note: The difference among the treatments marked with different lowercase letters in the same column is significant (p < 0.05), and the same letter indicates that the difference is insignificant.

After harvesting, a difference was observed in the content of soluble solids among treatments (Table 5). The effect of spraying calcium nitrate and naphthalene acetic acid on the initial soluble solid content was insignificant. The content of the control group was the highest, which was significantly less than that of the control group with 0.5% Ca(NO₃)₂ and 1% Ca(NO₃)₂ treatments. The difference between the two treatments was insignificant. The treatment of 0.5% Ca(NO₃)₂ + 30 mg·L⁻¹ NAA was significantly lower than the above treatment. The content of 1% Ca(NO₃)₂ + 30 mg·L⁻¹ NAA treatment was the lowest, and the difference was significant compared with other treatments.

Fig. 1 shows that the content of the entire treatment gradually decreased overall. During the 3rd–12th period of storage, the content decreased significantly. For 0.5% Ca(NO₃)₂, 1% Ca(NO₃)₂, 0.5% Ca(NO₃)₂ + 30 mg·L⁻¹ NAA, and 1% Ca(NO₃)₂ + 30 mg·L⁻¹ NAA treatments, the contents were 13.4%, 13.3%, 12.6%, 11.6%, and 15.1%, respectively. After 15 days of storage at low temperature, the values became 11.2%, 10.5%, 11.2%, 9.9%, and 11.7%. The decline rates were 16.4%, 21.1%, 11.1%, 14.7%, and 22.5%. Among them, 0.5% Ca(NO₃)₂ + 30 mg·L⁻¹ NAA had the best effect and the lowest rate of decline. The content of each treatment was lower than that of the control group, and calcium can reduce the consumption of its content. The effect of mixing calcium with naphthalene acetic acid to reduce the consumption of soluble solids was remarkable. On the 0th–9th day of storage, the rate of decrease in content was significantly different, and the retardation was significant.

3.2.2 Effects of different treatments on titratable acid content in fig fruits

After harvesting, the titratable acid contents varied among the treatments, and the differences were significant (Table 5). After the application of calcium nitrate, the content was significantly reduced;
high calcium nitrate concentration led to low titratable acid content. The decrease in titratable acid content was pronounced in the treatment of Ca(NO\(_3\))\(_2\) + naphthalene acetic acid. The content of the control group was the highest, and that of the control group with 0.5% Ca(NO\(_3\))\(_2\) treatment was significantly lower; 1% Ca(NO\(_3\))\(_2\) treatment was significantly less than that of the 0.5% Ca(NO\(_3\))\(_2\) treatment; 0.5% Ca(NO\(_3\))\(_2\) + 30 mg L\(^{-1}\) NAA treatment was significantly lower than that of the 1% Ca(NO\(_3\))\(_2\) treatment. The content of 1% Ca(NO\(_3\))\(_2\) + 30 mg L\(^{-1}\) NAA treatment was the lowest, and the difference was significant.

With prolonged storage time of the fruit, the titratable acid content gradually decreased. Fig. 2 illustrates that the overall trend was a gradual decrease. During the 6th–12th day of storage, the reduction effect was significant. For 0.5% Ca(NO\(_3\))\(_2\), 1% Ca(NO\(_3\))\(_2\), 0.5% Ca(NO\(_3\))\(_2\) + 30 mg L\(^{-1}\) NAA, and 1% Ca(NO\(_3\))\(_2\) + 30 mg L\(^{-1}\) NAA treatments, the acid contents of the solution after titration were 0.23%, 0.21%, 0.18%, 0.12%, and 0.26%, respectively. When stored for 15 days at low temperature, the contents were 0.11%, 0.07%, 0.08%, 0.07%, and 0.06%. The decline rates of titratable acid content were 52.2%, 66.7%, 55.6%, 41.7%, and 77.0%. Among them, 1% Ca(NO\(_3\))\(_2\) + 30 mg L\(^{-1}\) NAA had the best effect, and the titratable acid had the lowest rate of decline. The content of each treatment was lower than that of the control group, and calcium can reduce the consumption of its content. However, treatment with NAA in 0.5% Ca(NO\(_3\))\(_2\) had no significant effect on reducing the consumption of titratable acid. The effect of NAA on the consumption of titratable acid was insignificant. On the 6th–12th day of storage, the rate of decrease in the content was large, and the retardation was significant.

3.2.3 Effects of different treatments on vitamin C content in fig fruits

After harvesting, a difference in vitamin C content existed among treatments (Table 5), and 0.5% Ca(NO\(_3\))\(_2\) treatment was higher than 1% Ca(NO\(_3\))\(_2\) treatment. The control group had the highest content; compared with the control group, 1% Ca(NO\(_3\))\(_2\) + 30 mg L\(^{-1}\) NAA and 1% Ca(NO\(_3\))\(_2\) treatments were significantly less, and the difference between the two treatments was insignificant. The treatment of 0.5% Ca(NO\(_3\))\(_2\) + 30 mg L\(^{-1}\) NAA was significantly lower than the above treatment. The content of 0.5% Ca(NO\(_3\))\(_2\) treatment was the lowest, and the difference was significant compared with other treatments.

With prolonged fruit-storage time, the vitamin C content exhibited a tendency to stabilize first and then gradually decrease. Fig. 3 shows that the vitamin C content in each treatment gradually decreased. During the 0th–6th day period of storage, the rate of decrease was insignificant; during the 6th–15th day period, the rate of decrease was accelerated. For 0.5% Ca(NO\(_3\))\(_2\), 1% Ca(NO\(_3\))\(_2\), 0.5% Ca(NO\(_3\))\(_2\) + 30 mg L\(^{-1}\) NAA, and 1% Ca(NO\(_3\))\(_2\) + 30 L\(^{-1}\) NAA treatments, the decline rates of the content after harvesting were 41.2%, 42.3%, 24.0%, 38.9%, and 60.0%, respectively. Among them, 0.5% Ca(NO\(_3\))\(_2\) + 30 mg L\(^{-1}\) NAA had the best effect and the lowest rate of decline. The content of each treatment was lower than that of the control group. Calcium can reduce the consumption of its content, and the effect of mixing calcium with naphthalene acetic acid to reduce the consumption of
vitamin C was remarkable. On the 3rd–15th day of storage, the rate of decrease was large, and the effect of delaying the decrease of vitamin C was significant at this stage.

3.2.4 Effects of different treatments on soluble sugar content in fig fruit

After harvesting, a difference in soluble sugar content was found among treatments (Table 5). The initial content of Ca(NO₃)₂ treatment was significantly lower than that of the control group, and the content of calcium nitrate and naphthalene acetic acid treatment was the lowest. The control group had the highest content, and the contents of the 0.5% Ca(NO₃)₂ and 1% Ca(NO₃)₂ treatments were significantly low. The difference between the two treatments was insignificant. The 0.5% Ca(NO₃)₂ + 30 mg L⁻¹ NAA and 1% Ca(NO₃)₂ + 30 mg L⁻¹ NAA treatments were significantly lower than the above treatment, and the difference between the two treatments was insignificant.

With prolonged fruit-storage time, the soluble sugar content initially stabilized and then gradually increased. Fig. 4 shows that during the 0th–6th day period of storage, the rate did not change significantly. During the 6th–12th day, the increase rate was accelerated, and the rising speed stabilized on the 12th–15th day. After statistical analysis, for 0.5% Ca(NO₃)₂, 1% Ca(NO₃)₂, 0.5% Ca(NO₃)₂ + 30 L⁻¹ NAA, and 1% Ca(NO₃)₂ + 30 mg L⁻¹ treatments, the rates of NAA-treatment increase after harvesting were 18.0%, 18.1%, 14.0%, 18.8%, and 18.2%, respectively. Except for the 0.5% Ca(NO₃)₂ treatment, the increase rate difference was insignificant. The effect of preharvest calcium and NAA on the stability of soluble sugar content in fruits was insignificant.

4. Discussion and Conclusion

The fruit rind is composed of cell walls with cellulose and pectin. Ke Yuqing et al. [18] indicated that calcium is the intermediary of pectin synthesis; calcium treatment can enhance fruit hardness; calcium
can also inhibit the activity of polygalacturonase and pectin methylesterase, thereby reducing the fruit pectin substance decomposition. For 0.5% Ca(NO$_3$)$_2$, 1% Ca(NO$_3$)$_2$, 0.5% Ca(NO$_3$)$_2$ + 30 mg·L$^{-1}$ NAA, and 1% Ca(NO$_3$)$_2$ + 30 mg·L$^{-1}$, the rot rate of NAA treatment was significantly lower than that of the blank control. This conclusion is consistent with the results of this experiment. According to the research by Tiejinjin et al. [19, 20], calcium can inhibit the respiration of fruits, weaken the metabolism of endogenous substances in fruits, and strengthen their oxidative capacity, thereby inhibiting the respiration intensity of fruits and improving their storage quality. The test showed that different treatments were superior to the control, and the conclusion is consistent with the results of this test. Calcium also regulates the ionic environment and enzyme activity, which affects the storage quality of fruits [18]. Further research is needed.

Fu Runshan et al. [21, 22] showed that NAA can delay fruit ripening and softening and prolong shelf life. The fruit-rot rate for the calcium + naphthalene acetic acid treatment group is 55%–70% lower than that of the control, which is superior to that of the calcium-alone treatment group, consistent with the results of the present study. Yan Ying et al. [23] showed that the mechanism of action of NAA is that NAA can promote the operation of calcium and increase the amount of calcium absorbed by plants. However, results showed that the 0.5% Ca(NO$_3$)$_2$ + 30 mg·L$^{-1}$ NAA treatment was better than the 1% Ca(NO$_3$)$_2$ + 30 mg·L$^{-1}$ NAA treatment, which was inconsistent with the conclusion. The possible reason was the different horticultural plant species. NAA can promote the absorption of calcium and can be used as a separate influencing factor, and the effect of promoting calcium operation was significantly lower than that of NAA alone. Gao Liping and other studies [24] have shown that NAA does not influence calcium absorption and it is a separate factor affecting fruit-storage quality. The effect of calcium nitrate and naphthalene acetic acid in this test was significantly better than that of calcium nitrate and the control group. The conclusion is consistent. NAA can control the activity of polyamine synthase, stimulate the content of polyamines in the fruit, and act simultaneously with exogenous polyamines to delay the aging of fruits [9].

Calcium nitrate and NAA can effectively maintain the content of nutrients in the fruit before harvesting the “Popular Red,” which delayed the deterioration of the fruit and improved the storage quality of the fig fruit. The hardness of the fruit was increased, and the rate of change was significantly reduced. Compared with the control, the change rates of fruit-rot rate, soluble solids, titratable acid, and vitamin C decreased by 55%–70%, 34.7%–50.7%, 27.8%–54.8%, and 35.2%–60%, respectively. The effect was significantly better than that of the control group and the calcium nitrate-alone treatment group. However, compared with the control group, the weight-loss rate of the fruit and the slowing rate of soluble sugar were –8.3%–0% and 0.56%–3.3%, respectively, and the effect was not significant. In this experiment, the storage quality of fig fruit was the best when treated with 0.5% Ca(NO$_3$)$_2$ + 30 mg·L$^{-1}$ NAA.

References

[1] H. Heru, Zhang Shihua, Zhu Li, et al. Commercialization of figs and their storage, preservation and processing[J]. Agricultural Products Processing, 2017, (7): 53-56.
[2] Morcelle S R, Trejo S A, Canals F, etal.. Cysteine endopeptidase purified from the latex of funatrum clausum [J]. The protein journal, 2004, 23(3): 205-215.
[3] H. Wei. Effects of different fresh-keeping treatments on the quality changes of figs in different circulation processes [D]. Shijiazhuang: Hebei Agricultural University, 2013.
[4] H. Yinxia,L. Weidong, Y. Liqin, et al. Effects of pre-harvest calcium on the decay rate and sugar acid content of Eurasian fruit during storage[J]. FOOD SCIENCE, 2016, 37(14): 247-252.
[5] L. Zhongyong, H. Longhui, S. Juan, et al. Effects of Calcium on the Growth Quality of Nectarine Fruits in High Nitrogen Level[J]. Chinese Journal of Soil and Fertilizer, 2014(4): 72-75.
[6] Goutam M, Dhaliwal Hs, Mahajan Bvc. Effect of preharvest calcium sprays on post-harvest life of winter guava[J]. Food Scientists and Technologists, 2010, 47(5): 501-506.
[7] W. Zhu, W. Yuan, W. Qun. Effects of Calcium Preparation and Growth Regulator Treatment on Strawberry Fruit Quality and Plant Growth[J]. Journal of Hubei Agricultural Sciences, 2014, 53(20): 4870-4873.

[8] W. Rencai, Y. Ruixiang, Y. Huizhen, et al. Effects of Calcium Treatment on Fruit Storage and Quality in Kiwifruit Fruits[J]. Fruit Science, 2000, 17(1): 45-47.

[9] G. Ruixiang, W. Rencai, G. Wenqiang. Effects of calcium and naphthaleneacetic acid on the effect of spermidine on kiwifruit during storage[J]. Journal of Fruit Science 2003, 20(3): 186-189.

[10] W. Hewei, H. Yongjian, L. Wei, et al. Effects of naphthaleneacetic acid on nutritional quality and residual dynamics of potato during storage[J]. Science and Technology of Food Industry, 2018, 39(9): 272-277.

[11] W. Qinlin. Introduction performance and high-yield cultivation techniques of Poggi red fig[J]. Anhui Agricultural Sciences, 2006, 34(11): 2369-2390.

[12] X. Yan, H. Jianchang, L. Hongbin. Effects of Calcium and Naphthalene Acetic Acid on the Storage Resistance of Myrica rubra Fruit[J]. Journal of Southwest Agricultural University, 1999, 21(4): 307-310.

[13] W. Wei, Miao Xinqi, Q. Baihong. Effects of calcium and naphthaleneacetic acid on the quality of apple pear fruit [D]. Yanbian: Yanbian University Graduate School, 2008.

[14] T. Xia, Z. Ming, Ma Junlian, et al. Effects of different storage temperatures and ozone ice film treatment on fig storage and physiological changes[J]. Transactions of the Chinese Society of Agricultural Engineering, 2015, 31(12): 23.

[15] Z. Huijuan, Y. Zhengwen, S. Mingshen, et al. Effects of Different Concentrations of Calcium Spraying on the Storage Quality of 'Huyou' O18 Storage before Harvest[J]. Journal of Economic Research, 2014, 32(3): 123-128.

[16] Q. Yumei, Gao Liping, Zhang Yuqiong, et al. Effects of postharvest pre-warming treatment on the storage and preservation of strawberry fruit[J]. Biology Journal, 2006, 23(2): 50-53.

[17] L. Yuanhui. Effects of 1-MCP and chitosan treatment on fig storage quality and physiology [D]. Chengdu: Sichuan Agricultural University, 2016.

[18] K. Yuqing, Z. Changfeng. Physiological Effects of Calcium on Postharvest Fruits[J]. Journal of Yangtze University, 2007, 3, 66(2): 36-37.

[19] Y. Tiejin, F. Hongxia, C. Wenhong. Postharvest Physiological Effects and Fresh-keeping Effects of Calcium and Heat Shock Treatment on Figs[J]. FOOD SCIENCE, 2003, 24(7): 150-154.

[20] X. Peirong, M. Xiaohua, O. Juying. Effects of Pre-harvest Calcium Treatment on Postharvest Quality and Anti-aging of Mudong Yangmei Fruit[J]. Chinese Agricultural Science Bulletin, 2009, 25(7): 82-85.

[21] F. Runshan, J. Nina, R. Jingping, et al. Effects of Gibberellin and Naphthalene Acetic Acid on Physiological Indexes of Postharvest Ripening and Softening of Persimmon Fruit[J]. Acta Botanica Sinica, 2010, 30(6): 1204-1208.

[22] W. Zhongfeng, Z. Min, Z. Jie, et al. Effects of Naphthaleneacetic Acid on Postharvest Ripening and Softening of Strawberry[J]. FOOD SCIENCE AND TECHNOLOGY, 2011, 36(2): 31-35.

[23] G. Ying, M. Jieqi. Effects of pre-harvest lime water plus IAA and GA treatment on the storage of “Yulu” peaches[J]. Journal of Zhejiang Agricultural University, 1992, 18(3): 65-69.

[24] G. Liping, T. Hanzhi, C. Suzhen, et al. Effects of calcium and naphthaleneacetic acid on the storage of kiwifruit fruits[J]. Journal of Anhui Agricultural University, 1996, 13(2): 115-116.