Study on Preservation Effect of Tea Polyphenol and Tea Saponin mixture on Grape

Jingyi Xu[a, *], Xiaomei Li, Mengze Du, Chunlei He, Xiao Du, Jinlin Bian

Tea Department of College of Horticulture Science, Sichuan Agricultural University, Chengdu 611380, Sichuan, China

[a]xujytea@126.com

*Corresponding author

Keywords: Tea saponin, tea polyphenol, coating, summer black grape, preservation

Abstract: In order to study the preservation effect of the mixture of tea saponin and tea polyphenol on fruit, different concentrations of tea saponin mixed with different concentration of tea polyphenols were used to study the preservation effect of coating on grape. The results showed that when the concentration of tea saponin reached 6%, the hardness, the contend of soluble solids and titratable acid decreased most slowly on the 10th days, compared with the blank control. When the concentration of tea saponin mixed with tea polyphenol was 6%, the weight loss rate of grape was the lowest and the content of Vc was the highest with the storage days. Going on The preservation effect of the mixture of tea saponin and tea polyphenols was better than that of the single substance.

1. Introduction

The Grapevine CV. Summer Black is one of the most popular grape varieties in the Chinese market due to its high yield, high quality, and beautiful shape, non-nuclear and good taste. However, because of its soft and juicy content and high moisture content, it is easy to spoil and deteriorate during harvesting, transportation and storage. Therefore, extending the shelf life and increasing the value of its products is an urgent problem to be solved in the production and circulation. At present, the preservation methods may cause bleaching damage during grape storage and affect human health [1]. Therefore, it is urgent to seek a safe and convenient method for preservation.

Tea saponin is a pentacyclic triterpenoid compound extracted from the seeds of Camellia plant [2], and it is a pure natural non-ionic surfactant and has the function such as antibacterial and antiseptic, inhibiting plant pathogens and common pathogenic bacteria in food [3, 4]. Tea polyphenols are the main functional components in tea, and have the effect of inhibiting bacterial growth and preventing food spoilage [5-7]. The preservation effect of tea saponin and tea polyphenol in the compound pairing to Summer Black was studied with the coating method in this paper.

2. Materials and methods

2.1 Preparation of coating film

Summer black grape the test grapes were purchased from ten thousand mu grape industrial park of Peng Shan county, Sichuan province. Tea polyphenol was provided by Sichuan Clooney tea biotechnology co., LTD. Tea saponin was provided by Hangzhou Zhengyi natural plant technology co., LTD

Tea saponin was dissolved in distilled water. The coating solution with a concentration of 2%, 4%, 6%, 8% and 10% was prepared for later usage. 3g tea polyphenols were added into tea saponin solution with the configured concentration of 2%, 4%, 6%, 8% and 10% respectively for later use. 0.005% sodium met bisulfite was prepared as the coating solution for later usage.

2.2 Grape preservation treatment

80-90% mature “summer black” grapes were washed and dried and were immersed in tea saponin coating solution, tea saponin and tea polyphenol coating soluted for 10 minutes respectively, which were recorded as treatment A1-A5, B1-B5, distilled water (CK1) was recorded as negative control, and 0.005% sodium met bisulfite (CK2) as positive control.

Each treatment should be repeated 3 times, each treatment with 400g of fruit, naturally dried after soaking, and then put into the grape storage bag with a small amount of holes in the bag, and then put the bag into the constant temperature and humidity box (temperature 20°C, humidity 80%), sampling and measuring relevant indicators every 48 hours.

2.3 Project measurement and method

The weight method was used to determine the weight of grapes and the mass of the grapes was weighed by the balance. The weight loss rate was calculated as follows:

(1) Weight loss rate (%) = [(fruit weight before storage - fruit weight after storage)/ fruit weight before storage] × 100%

The counting method was used to determine the number of rot fruit and the total number of fruit pieces, and the following formula was calculated:

(2) Fruit rot rate = number of rot fruit / total number of fruit × 100%.

The Vc content was determined (mg Vc/g) by 2, 6-dichloroindophenol titration [8].The samples were peeled and squeezed, and PAL-1 hand-held refractive index meter and was used to determine the content of soluble solids in fruits.Each group of samples was measured 3 times and the average value was taken.

In each treatment, 10 fruit grains (including skin) were randomly selected and tested with FHM-5 fruit hardness tester [9]. Five different points were measured at each fruit grain and the average value was taken. Two points were around the fruit stalk, two points were in the middle of the fruit grain, and one point was the fruit stalk at the opposite position. The samples were peeled, squeezed, and determined by alkali titration. Each group was determined three times and the mean value was taken.

3. Results and discussion

3.1 Effects of Different Treatments on Weight Loss Rate of Summer black grape

As seen from Table 1, the negative control treatment of coating distilled water (CK_1) had a higher weight loss rate. The positive control treatment of coating sodium met bisulfite (CK_2) and the composite film treatment of the tea polyphenol and tea saponin had smaller weight loss rate. On the 10th day of storage, the weight loss rate of tea saponin film agent treatment group was significantly higher than that of tea saponin and tea polyphenol composite film agent treatment group ($P < 0.01$). In the treatment of tea saponin film agent, the weight loss rate of A_1 and A_2 was significantly lower than that of CK_2 ($P<0.01$), and the weight loss rate of other treatment was significantly higher than that of CK_2 ($P<0.01$), which indicated that the most suitable concentration of tea saponin was 4%. As can be seen from Table 1, the weight loss rate of grapes treated with tea saponin and tea polyphenol coating agent was significantly lower than that of tea saponin coating agent group, CK1 group and CK2 group ($P < 0.01$), among which B_3 treatment had the best effect.

Table 1. The treatment effect on summer black grapes of weightlessness rate (%)

treatment	0d	2d	4d	6d	8d	10d
CK_1	0	0.52±0.10Aa	1.10±0.20Aa	1.95±0.03Aa	1.78±0.02Aa	1.39±0.03Aa
CK_2	0	0.40±0.07Bb	0.57±0.11Ccd	0.52±0.02Hij	1.00±0.10CDEde	0.98±0.02De
A_1	0	0.42±0.04Bb	1.07±0.16Aa	1.19±0.01Bb	0.92±0.03Ef	0.90±0.02Ef
A_2	0	0.30±0.10DEde	0.58±0.07Cc	1.14±0.03Bc	1.04±0.02BCcd	0.89±0.02Ef
A_3	0	0.26±0.09FGfg	0.46±0.04CDEde	0.54±0.03Hi	1.00±0.04CDEde	1.18±0.02Cd
A_4	0	0.21±0.07Ii	0.41±0.04DEFef	0.71±0.02FGg	0.77±0.03Fg	1.21±0.02Cc
A_5	0	0.18±0.06Jj	0.37±0.03EFefg	0.67±0.02Gh	1.05±0.08BCcd	1.30±0.02Bb
B_1	0	0.36±0.10Cc	0.85±0.07Bb	0.68±0.02Ggh	1.08±0.02BCbc	0.69±0.03Hi
B_2	0	0.23±0.07HIhi	0.53±0.04CDcd	0.91±0.03De	1.03±0.02CDcd	0.59±0.00Ij
B_3	0	0.17±0.05Jj	0.30±0.02Ffg	0.50±0.02Hj	0.70±0.00Fh	0.49±0.01Jk
B_4	0	0.28±0.04EFef	0.47±0.03Gf	0.75±0.02EFf	1.12±0.03Bb	0.73±0.02Gh
B_5	0	0.32±0.04Dd	0.66±0.05EFfg	1.04±0.03Cd	0.95±0.03DEef	0.79±0.02Fg

3.2 Effects of different treatments on Vc content of Summer black grape

As seen from Table 2, the Vc content of summer black grapes under different treatments decreased continuously with the storage time going on. At the 10th day of storage, the Vc content of CK1 was lower than that of other treatment groups. Among them, B3 treatment had the best effect, which was significantly different from CK1 ($P < 0.01$).

Table 2. The treatment effect on summer black grapes of Vc content (mg/100ml)

treatment	0d	2d	4d	6d	8d	10d
CK_1	4.03	2.50±0.10Abc	1.85±0.05Ccd	1.51±0.38Bc	1.12±0.31Bb	1.04±0.45Bb
CK_2	4.03	2.82±0.99Aabc	2.17±0.75ABCabc	1.95±0.00ABbc	1.08±0.37Bb	1.00±0.32Bb
A_1	4.03	3.80±0.17Aab	3.28±0.05ABab	1.95±0.65ABbc	1.52±0.37ABb	1.45±0.44ABab
A_2	4.03	2.28±0.33Ac	1.82±0.85Ccd	1.80±0.71ABbc	1.08±0.37Bb	1.12±0.31Bb
A_3	4.03	3.25±0.65Aabc	1.73±0.75Cd	1.71±0.36Bbc	1.30±0.00Bb	1.52±0.38ABab
A_4	4.03	3.47±0.37Aabc	1.95±0.65BCcd	1.73±0.43Bbc	1.39±0.53Bb	1.32±0.42ABb
A_5	4.03	3.25±0.65Aabc	1.95±0.65BCcd	2.38±0.75ABab	1.60±0.31ABb	1.49±0.63ABab
B_1	4.03	3.03±0.17Aabc	2.17±0.38ABCcd	1.73±0.37Bbc	1.70±0.35ABab	1.52±0.20ABab
B_2	4.03	2.38±1.91Ac	1.76±0.46 Cd	1.73±0.37Bbc	1.71±0.36ABab	1.52±0.20ABab
B_3	4.03	3.82±0.06Aa	3.42±0.01Aa	2.82±0.38Aa	2.35±0.95Aa	2.11±0.65Aa
B_4	4.03	3.09±0.43Aabc	2.28±0.03ABCbcd	1.52±0.37Bc	1.38±0.14Bb	1.30±0.65ABb
B_5	4.03	3.69±1.00Aab	2.17±0.75ABCcd	1.73±0.37Bbc	1.52±0.75ABb	1.39±0.15ABab

3.3 Effects of Different Treatments on Soluble Solids of Summer black grape

It can be seen from Table 3 that the soluble solids of each treatment generally showed an increasing trend at first and then decreased, and most of them were the highest on the second or fourth day of storage. Soluble sugar accumulated and the soluble solid increased in the early stage of storage, while the trend was the opposite in the later stage. In the treatment groups, A3 treatment had the best effect, which was significantly different from CK_1 ($P < 0.05$) and CK_2.

Table 3. The treatment on the effect of summer black grape soluble solids (%)

treatment	0d	2d	4d	6d	8d	10d
CK_1	15.03	15.23±0.57Bc	17.13±0.61Aabc	16.17±0.23Aab	15.40±0.36Ab	14.27±0.87Ab
CK_2	15.03	17.53±0.35ABab	17.07±0.38Aabc	16.83±0.90Aab	15.47±0.51Aab	15.03±0.32 Aab
A_1	15.03	16.50±2.01ABbc	17.93±0.60Aa	16.60±0.70Aab	15.37±2.19Ab	15.23±2.03Aab
A_2	15.03	16.13±2.05ABbc	17.10±2.05Ac	16.17±0.30Aab	15.93±0.45Aab	15.63±0.67Aab
A_3	15.03	18.30±0.78Aa	18.03±0.96Aa	16.90±1.10Aab	16.70±0.44Aa	16.07±0.42Aa
A_4	15.03	17.30±0.89ABab	17.73±0.74Aab	16.87±0.33Aab	16.57±0.47Aab	15.27±1.46Aab
A_5	15.03	17.43±0.06ABab	17.23±1.36Aabc	16.23±1.05Aab	15.97±0.80Aab	15.77±0.29 Aa
B_1	15.03	17.70±0.52Aab	17.03±1.06Aabc	16.67±0.55Aab	16.40±0.70Aab	15.97±0.31Aa
B_2	15.03	17.57±0.60Aab	17.70±0.44Aab	17.03±1.39Aa	16.10±0.20Aab	15.27±0.42 Aab
B_3	15.03	16.10±1.83ABbc	16.47±1.76Abc	16.20±0.78Aab	15.90±0.17Aab	15.13±0.78Aab
B_4	15.03	16.70±0.95ABabc	17.40±1.22Aabc	15.50±0.96Ab	15.85±0.05Aab	15.77±0.64Aa
B_5	15.03	16.07±0.58ABbc	17.07±0.51Aabc	16.03±1.06Aab	16.10±0.40 Aab	15.27±0.57 Aab

3.4 Effects of Different Treatments on Fruit Rot Rate of Summer black grape

It can be seen from Table 4 that the rot rate of each treatment showed an upward trend generally, which was relatively slow in the early stage and relatively faster in the later stage. The rot rate of the composite film treatment of the tea polyphenol and tea saponin was lower than that of CK1. The rot rate of CK_2 was significantly lower than that of CK_1. However, the concentration of SO_2 in the later stage decreased, so the fruit decay rate increased rapidly. Moreover, from the sixth day, black mildew appeared in the grape stalk with sodium pyro sulfite as the preservative. In general, A_2 treatment had a better effect. The grape rot rate of A2 increased slowly, which can maintain the freshness of grapes and extend the preservation life.

Table 4. The treatment on the effect of summer black grape fruit rot rate (%)

treatment	0d	2d	4d	6d	8d	10d
CK_1	0	6.20±0.02Aa	9.47±0.02Aa	11.58±0.02Aa	15.70±0.05Aa	23.10±0.03Aa
CK_2	0	3.12±0.04Ff	4.17±0.02Ff	6.25±0.00Ff	10.30±0.02Hh	18.21±0.02De
A_1	0	3.70±0.09Ee	4.63±0.04Ee	5.56±0.02Hh	11.11±0.02Gg	17.59±0.02Fg
A_2	0	0.91±0.00Kk	1.74±0.01Kk	2.61±0.03Kk	6.51±0.02Ll	12.10±0.03Km
A_3	0	1.71±0.01Ii	2.60±0.11Jj	4.27±0.02Jj	9.40±0.01Ii	12.82±0.01Jk
A_4	0	2.91±0.01Gg	3.88±0.02Gg	5.83±0.02Gg	11.65±0.03Ff	12.70±0.01Jl
A_5	0	5.22±0.03Cc	6.08±0.01Dd	7.83±0.00Dd	12.17±0.02Ee	16.52±0.02Gh
B_1	0	4.72±0.02Dd	6.54±0.02Cc	8.41±0.03Cc	13.08±0.02Dd	22.40±0.00Bc
B_2	0	5.41±0.01Bb	7.21±0.00Bb	9.01±0.02Bb	15.32±0.00Bb	22.52±0.02Bb
B_3	0	2.73±0.01Hh	3.64±0.04Hh	4.20±0.02Jj	8.18±0.02Jj	15.45±0.02Hi
B_4	0	1.00±0.02Jj	3.10±0.00Ii	7.00±0.17Hh	15.20±0.10Cc	20.00±0.20Cd
B_5	0	2.73±0.01Hh	3.64±0.02Hh	4.55±0.06Ii	8.18±0.02Jj	14.55±0. 02Ij

3.5 Effects of Different Treatments on Fruit Hardness of Summer black grape

It can be seen from Table 5 that the hardness of the grapes under different treatments showed a downward trend with the increase of storage time generally. The rate of decline in the early stage was slower, and the rate of decline in the later stage was faster. On the 10th day of storage, the hardness of A3 treatment was significantly higher than that of CK_1 ($P<0.05$).

Table 5. The treatment on the effect of summer black grape hardness (kg/cm2)

treatment	0d	2d	4d	6d	8d	10d
CK_1	0.70	0.60±0.05BCDcde	0.52±0.05Aabc	0.40±0.05CDef	0.35±0.06Aab	0.31±0.03ABbc
CK_2	0.70	0.67±0.03ABab	0.54±0.07Aabc	0.49±0.06ABab	0.36±0.01Aab	0.34±0.02Aabc
A_1	0.70	0.57±0.03CDde	0.51±0.07Abc	0.4±0.058ABabc	0.39±0.07Aab	0.32±0.05ABabc
A_2	0.70	0.65±0.04ABabc	0.50±0.12Ac	0.44±0.09ABCabcde	0.40±0.06Aab	0.37±0.05Aab
A_3	0.70	0.69±0.05Aa	0.55±0.05Aabc	0.47±0.06ABCabcd	0.44±0.08Aa	0.38±0.04Aa
A_4	0.70	0.64±0.06ABCabc	0.54±0.12Aabc	0.44±0.09ABCDbcde	0.35±0.03Aab	0.24±0.07Bd
A_5	0.70	0.63±0.07ABCbc	0.52±0.04Aabc	0.50±0.06Aa	0.40±0.04Aab	0.36±0.00Aab
B_1	0.70	0.60±0.03BCDcde	0.59±0.04Aabc	0.43±0.05BCDcde	0.38±0.03Aab	0.32±0.05Aabc
B_2	0.70	0.60±0.04BCDcde	0.59±0.05Aab	0.48±0.05ABab	0.38±0.17Aab	0.35±0.05Aabc
B_3	0.70	0.55±0.03De	0.50±0.02Ac	0.37±0.03Df	0.32±0.02Ab	0.31±0.09ABbc
B_4	0.70	0.69±0.02Aa	0.56±0.07Aabc	0.43±0.11BCDcde	0.37±0.07Aab	0.36±0.01Aabc
B_5	0.70	0.63±0.06ABCbc	0.54±0.01Aabc	0.47±0.03BCDcde	0.41±0.07Aab	0.35±0.09Aabc

3.6 Effects of Different Treatments on Titratable Acid of Summer black grape

As seen from Table 6, the titratable acids in fruits under each treatment showed a declining trend. The declining rate of titratable acid in grape filmed with tea saponin and tea polyphenol was lower than that of CK_1. Among them, A_3 treatment had better effect. On the 10th day of storage, the titratable acid of A_3 was significantly higher than that of CK1 ($P<0.05$).

Table 6. The treatment on the effect of summer black grapes titratable acid (g/100ml)

treatment	0d	2d	4d	6d	8d	10d
CK_1	0.44	0.31±0.04ABabc	0.28±0.01Cc	0.27±0.00Bc	0.26±0.00Cc	0.24±0.03ABbc
CK_2	0.44	0.31±0.01ABabc	0.30±0.00ABab	0.29±0.01ABab	0.28±0.00ABab	0.26±0.01Aabc
A_1	0.44	0.31±0.01ABabc	0.30±0.01ABab	0.29±0.03ABab	0.29±0.00Aa	0.27±0.01ABabc
A_2	0.44	0.33±0.02Aa	0.30±0.00ABab	0.29±0.00ABab	0.28±0.00ABab	0.26±0.01Aab
A_3	0.44	0.33±0.01Aa	0.31±0.01Aa	0.30±0.02Aa	0.29±0.00Aa	0.28±0.01Aa
A_4	0.44	0.32±0.01ABab	0.31±0.01Aa	0.30±0.00Aa	0.29±0.00Aa	0.28±0.00Bd
A_5	0.44	0.32±0.00ABab	0.30±0.01ABab	0.29±0.01ABab	0.28±0.00ABab	0.26±0.00Aab
B_1	0.44	0.30±0.01ABbc	0.29±0.01BCbc	0.28±0.00ABbc	0.28±0.01ABab	0.27±0.00Aabc
B_2	0.44	0.30±0.01ABbc	0.29±0.01BCbc	0.28±0.01ABbc	0.27±0.01BCbc	0.26±0.01Aabc
B_3	0.44	0.32±0.00ABab	0.29±0.00BCbc	0.30±0.01Aa	0.29±0.00Aa	0.27±0.01ABbc
B_4	0.44	0.31±0.00ABabc	0.30±0.00ABab	0.29±0.01ABab	0.28±0.01ABab	0.26±0.00Aabc
B_5	0.44	0.29±0.01Bc	0.28±0.00Cc	0.28±0.00ABbc	0.27±0.01BCbc	0.25±0.00Aabc

4. Conclusion

Tea saponin has antibacterial and bactericidal effects. Tea polyphenols are antioxidants. Tea saponin and tea polyphenol are used as film agents to cover the grape, forming a layer of film on the surface of grape fruit grains that can inhibit bacterial growth [10]. The results showed the appropriate concentration of tea saponin and tea polyphenol compound solution could inhibit the growth of microorganisms, and prevent food deterioration and prolong the effect of food preservation significantly. In summary, from the changes of grape hardness, soluble solids and titratable acid content, it can be seen that tea saponin and tea polyphenols had a certain preservation effect, which can be used as a new type preserver in the future.

Acknowledgements

Funding for this research was provided by the Project 063H2301 of Sichuan Agricultural University.

References

[1] X. M. Yan, Y. L. Fu. Advances in Research on the Storage of Grapes [J]. Chinese Horticulture Abstracts, 2012 (10): 17 - 18.

[2] W. Li, L. Wei, J. Qian. Toxicity, Irritation and Bacteriostatic of Tea Saponin [J]. China Oils and Fats, 2011, 36 (6): 58 - 60.

[3] S. Y. Wang. A Natural Surfactant with Excellent Properties — Tea Saponin [J]. China Surfactant Detergent & Cosmetics, 1987 (2): 32 – 34.

[4] J. G. Huang, X.X. Chen, H.H. Xu. Studies on inhibitory activity of tea saponin against twelve Plant pathogenic fungi [J]. Journal of Huazhong Agricultural University, 2013, 32 (2): 50 – 53.

[5] K. Hayashi, Sagesna. Use of tea components as antifungal agents [J]. JP A2, Aug20, p 4.

[6] F. X. Qu. Effects of Tea Polyphenols on Water Chestnut of Room Temperature Preservation [J]. Northern Horticulture, 2012 (05): 162 - 164.

[7] C. S. Guo, L.Y. Zhang. Properties and preservation effect of tea polyphenol-incorporated soy protein isolate antibacterial films [J]. Journal of Beijing University of Chemical Technology (Natural Science Edition), 2011, 38 (4): 3 - 20.

[8] G. H. Zhao. Principles and techniques of food chemistry experiments [M]. Beijing: Chemical industry press, 2009: 105 – 108.

[9] J. M Wu, M. Zhong, B. Wu. Study on SO2 Accumulation on Table Grapes in Storage [J]. Food Science, 2008, 29 (3): 486 – 487.

[10] Q. L. Mao, Z.P. Shi, Ling Li. Research Advances of Health and Pharmacological Functions of Tea Cate chins [J]. Food Science, 2007, 28 (8): 584 – 588.