RESEARCH ARTICLE | FEBRUARY 28 2019

Effects of glutathione on the ripening quality of strawberry fruits FREE

Cong Ge; Ya Luo; Fan Mo; Yi-Hu Xiao; Nan-Yu Li; Hao-Ru Tang

AIP Conf. Proc. 2079, 020013 (2019)
https://doi.org/10.1063/1.5092391

Effects of Glutathione on the Ripening Quality of Strawberry Fruits

Cong Ge[1, b)], Ya Luo[1, b)], Fan Mo[1, b)], Yi-Hu Xiao[1], Nan-Yu Li[1] and Hao-Ru Tang[1, a)]

[1]*College of Horticulture, Sichuan Agricultural University, Chengdu 611130, Sichuan, China*

[a)]Correspongding author: htang@sicau.edu.cn
[b)]These authors contributed equally to this work.

Abstract: Strawberries are popular because of their sweetness, rich nutrition, and significant health benefits. However, in the actual production and cultivation, the ripening and aging cycle of strawberry is short, especially in spring and summer. The ripening and softening process of strawberry due to temperature and light conditions is rapid, resulting in poor fruit quality and flavor. Therefore, the quality of ABA of strawberry fruit ripening is studied. The content and the influence of the antioxidant system are of great significance. In this experiment, the effect of exogenous glutathione on the regulation of strawberry fruit ripening was studied by injecting 100 mM glutathione solution into the light green stage fruit. The results of the study showed that there was no significant change in the maturity-related parameters of the treated group compared with the control. The main antioxidants, total flavonoids and ascorbic acid content also increased, antioxidant capacity increased, and only the total phenolic content decreased slightly. In addition, in the early stage of fruit growth, ABA content was significantly higher than the control, but decreased in the later stage, slightly lower than the control. The results of this experiment indicated that the application of appropriate concentration of glutathione solution during the cultivation process could not significantly change the strawberry fruit ripening index, but could increase the content of endogenous antioxidants and improve the antioxidant capacity of strawberry. The increase of ABA content may be due to the decrease of active oxygen content, the stress mechanism inside the fruit, and the increase of ABA content to induce H_2O_2 to maintain the redox balance in the fruit.

INTRODUCTION

The fruit has two stages of maturity and softening during growth and development. When the fruit is fully mature, the aging softening stage begins [1]. In these two stages, a series of complex physiological and biochemical changes will occur in the fruit. It is found that in non-respiratory climacteric fruits, abscisic acid (ABA) is the main influencing factor of fruit ripening, which has been obtained in strawberries. It was confirmed that ABA can promote the coloration and softening of fruits such as strawberries and grapes [1-2].

Strawberry (*Fragaria* × *ananassa* Duch.) is native to South America and is widely cultivated in various parts of China and Europe. It is the second largest berry in China after planting area and yield. Its fruit is heart-shaped, full of color and flavor, the fruit is soft and juicy, nutritious and has good health care effect. It has the reputation of "Queen of Fruits" and is very popular among people. From ripening to softening cycle, strawberry is not resistant to storage and transportation, and economic loss is serious. When high temperature and strong light appear, strawberry coloring and softening process is rapid, and there are problems such as poor flavor. Therefore, under the premise of taking into account the nutritional value of strawberries, it is very necessary to improve the quality of strawberries and delay the ripening process of strawberries. In recent years, exogenous antioxidants have been widely used to improve the antioxidant capacity and quality of fruits. In the study of lychee, grape, apple and other fruits, it has been confirmed that exogenous antioxidants can increase the activity of antioxidant enzymes in fruits and improve their antioxidant capacity, which can effectively delay the mature aging process [3-5].

Glutathione (GSH) is the most abundant and abundant thiol-containing low molecular peptide widely distributed in plants and microbial cells. It is an important active substance in plants and can eliminate free radicals in living organisms. One of the most effective scavengers for intracellular metabolic processes and peroxides produced by

2018 International Conference on Biotechnology and Bioengineering (8th ICBB)
AIP Conf. Proc. 2079, 020013-1–020013-5; https://doi.org/10.1063/1.5092391
Published by AIP Publishing. 978-0-7354-1807-3/$30.00

plants under oxidative stress [6]. In the study of Wei *et al.* [7], the application of appropriate concentration of GSH can increase the activity of antioxidant enzymes and antioxidants, reduce the damage caused by reactive oxygen species to membrane lipids, and thus improve the quality of seedlings.

MATERIALS AND METHODS

Materials Collection

In this experiment, the well-grown strawberry variety 'Fragaria ananasa Duch.' was used as the experimental material. The material was taken from the Chongzhou Strawberry Base in Chengdu, Sichuan Province in 2016-2017.

Experimental Design

Using 100 mM glutathione solution as a treatment, and distilled water as a control, select the light green fruit with the same growth state and size (green gradually receded, about 17 days after flowering), and insert it from the tip of the fruit to the heart. About 200 μL, the needle is slowly pulled out while injecting. The treatment consisted of 3 repetitions, each of which repeated 8 strawberry fruits, and the fruits were picked every two days, and the strawberries were ground into powder with liquid nitrogen, mixed evenly, and stored in an ultra-low temperature freezer at -80 °C for use in determining the physiology index.

RESULTS AND DISCUSSION

Effect of Exogenous Glutathione on Ripening Index of Strawberry Fruit

The appearance quality of strawberry fruit is a key factor that directly affects the value of its commodity. As shown in Table 1, there was no significant effect on the hardness, single fruit weight, transverse and vertical diameter, and soluble solid content of mature strawberry fruits after GSH application compared with the control.

TABLE 1. Changes in quality parameters during fruit development

Treatment	Hardness (N)	Single fruit weight (g)	Soluble solid content (%)	Transverse diameter (cm)	Vertical diameter (cm)
GSH	2.94 ± 0.05^{ab}	17.63 ± 0.89^{a}	9.18 ± 0.29^{a}	3.26 ± 0.07^{a}	3.76 ± 0.07^{a}
CK	3.03 ± 0.05^{b}	17.17 ± 0.90^{a}	9.50 ± 0.18^{ab}	3.22 ± 0.07^{a}	3.66 ± 0.09^{a}

Note: Different letters in the same column indicate significant differences between treatments ($P<0.05$).

Effect of Exogenous Glutathione on Nutritional Index Content of Strawberry Fruit

As the strawberry fruit matured, its total phenolic content showed a decreasing trend. It is worth noting that the total phenolic content of the GSH-treated fruit decreased sharply on days 4-6 after treatment. However, when the fruit was fully mature, the total phenolic content of the GSH-treated group and the control group were 1.08 mg·g-1 and 1.25 mg·g-1, respectively, and there was no significant difference (Fig. 1A). This indicates that GSH treatment accelerates the metabolic process of total phenols, but has no effect on the total phenolic content of mature strawberry fruits. The application of GSH had significant effects on the total flavonoids content of strawberry. Especially on the 4th day after treatment, the total flavonoid content of strawberry fruit in GSH treatment group reached the maximum value of 0.49 mg·g-1, while the control group had the lowest value of 0.28 mg·g-1 (Figure 1B). In addition, ascorbic acid is an important antioxidant in strawberry fruit and an important indicator for measuring the nutritional quality of strawberries. During the growth and development of the GSH treatment group, the ascorbic acid content increased significantly, and the content of the ascorbic acid was the highest on the sixth day (Fig. 1C). This shows that GSH treatment will increase the total flavonoids and ascorbic acid content in strawberry fruit.

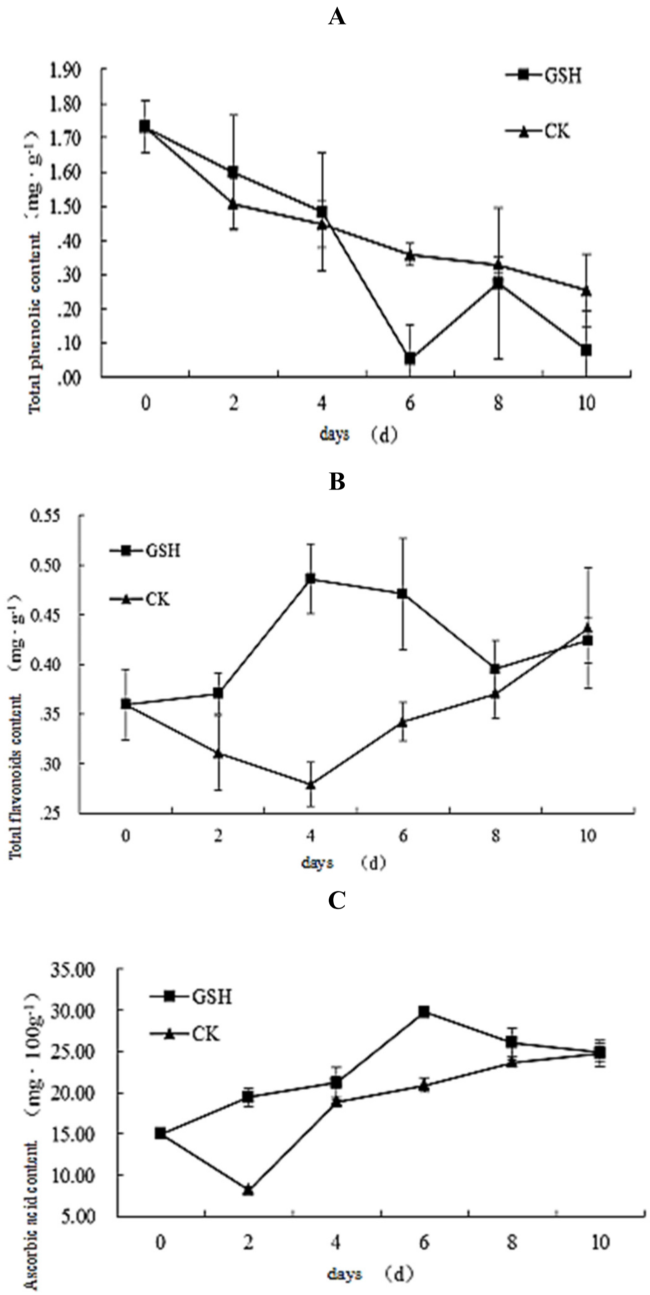

FIGURE 1. Trends of total phenolics, total flavonoids and ascorbic acid during strawberry growth and development

Effects of Exogenous Glutathione on Antioxidant Capacity, ABA and H_2O_2 Content in Strawberry Fruit during Development

The antioxidant capacity was determined by the iron reduction oxidation capacity method (FRAP). FRAP is a measure of the antioxidant capacity of strawberry fruit. As shown in Fig. 2, the observation of the color of the fruit in the field and the changes of nutrients in the early stage indicate that the treatment of GSH helps to increase the content of antioxidants in the fruit. ABA plays a key role in the ripening of strawberry fruit. As shown in Figure 3, as the number of treatment days increased, the ABA content of the strawberry treated by GSH increased rapidly, and then decreased overall. The ABA content of the control group fluctuated up and down obviously, and the rising trend was obvious during the full maturity stage of the fruit. As shown in Fig. 4, the change trend of H2O2 content in the GSH treatment group and the control group was similar, and both showed a phenomenon of decreasing first and then increasing. The active oxygen represented by H2O2 showed a significant decrease after GSH treatment, and the active oxygen was removed to a certain extent, reducing the oxidative damage to the fruit.

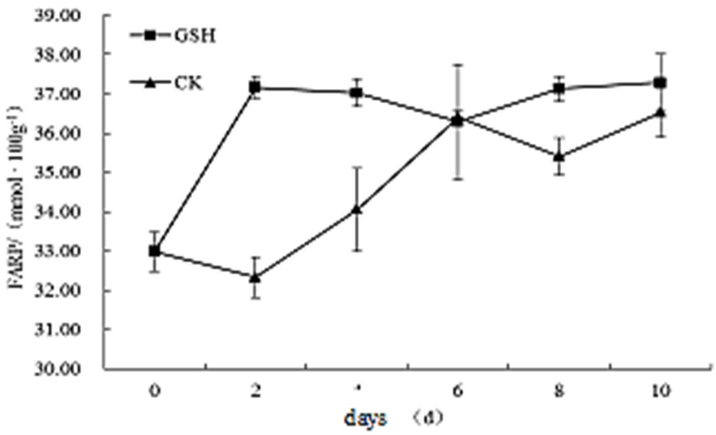

FIGURE 2. Trends in antioxidant capacity during strawberry fruit growth and development

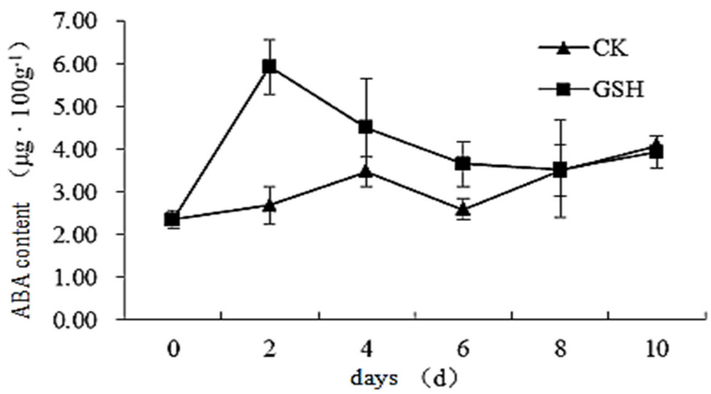

FIGURE 3. Trend of ABA content during the growth and development of strawberry fruit

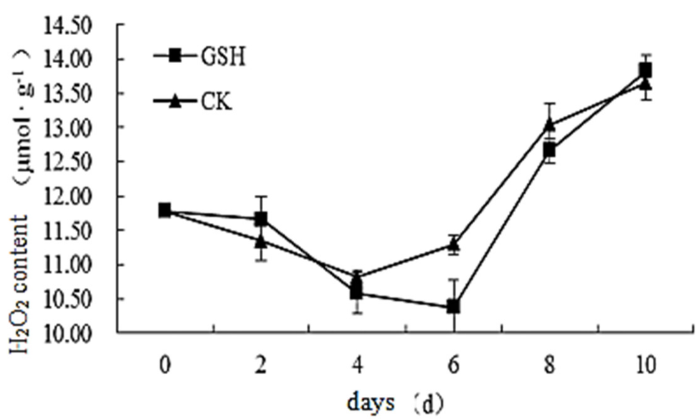

FIGURE.4 Trends of H_2O_2 content during the growth and development of strawberry fruit

CONCLUSION

Plant aging is closely related to reactive oxygen species. With the growth and development of plants, the contents of non-enzymatic antioxidants AsA, GSH and antioxidant enzymes in plants decrease, that is, the defense effect on active oxygen in plants is weakened, leading to accumulation of active oxygen and peroxidation, which promotes plant senescence. In rice, exogenous GSH can increase the activity of related enzymes and the contents of non-enzymatic antioxidants AsA and GSH in rice chloroplast active oxygen scavenging system under salt stress, and reduce the accumulation of reactive oxygen species represented by H2O2 in chloroplasts. The degree of damage caused by lipid peroxidation. Similar results were obtained in the study of Limonium and Yali fruit. Studies on Dianthus found that the appropriate concentration of exogenous GSH and AsA can increase the antioxidant content of Dianthus, and thus enhance the removal of active oxygen to delay the growth, which is consistent with the results of this study.

ACKNOWLEDGEMENTS

This work was supported by Natural Science Foundation of China (31801817), and Key Projects of Sichuan Provincial Education Department (172A0319).

REFERENCES

1. Y.T. Zhang, H.R. Tang, Q. Chen *et al.* Chinese Journal of Plant Physiology **51**, 813-820 (2015).
2. M. Zhang, B. Yuan, P. Leng. Journal of Experimental Botany **60**, 1579-1588 (2009).
3. Y.W. Mo, J.X. Zheng, W.C. Li, *et al.* Transactions of the Chinese Society of Agricultural Engineering **26**: 363-368 (2010).
4. W.J. Wang, Z.P. Wang, Chinese and Foreign Grapes and Wine **3**, 8-10 (2013).
5. J.Q. Zhang, Chinese Agricultural Science Bulletin **29**, 106-109 (2013).
6. Z.G. Li, Z.C. Xu, Y.S. Su, *et al.* Jiangsu Journal of Agricultural Sciences **22**, 118-121 (2010).
7. W. Yu, J.M. Qi , H.Z. Teng, *et al.*. Nuclear Agricultural News **1**, 196-207 (2018).