


RESEARCH ARTICLE | FEBRUARY 28 2019

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AIP Conf. Proc. 2079, 020009 (2019)

<https://doi.org/10.1063/1.5092387>



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Quality Performance of Seven Strawberry Varieties in Hanyuan

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Abstract: In this experiment, Hongyan, Zhangji, Xiaobai, Jiaoji, Zuixia, Shengdanhong and Taikong 2008 strawberry were used as experimental materials to measure and analyze the sensory quality and nutritional quality indicators so as to screen out suitable production and cultivation in Hanyuan area. The comprehensive traits of the excellent strawberry varieties. The results showed that the Hongyan strawberry fruit has a large fruit with an average fruit weight of 19.65g. The fruit is sweet and sour. The flavor is excellent. It shows good performance in nutritional quality indicators such as soluble solids, vitamin C, anthocyanins and flavonoids. It is also moderate, 2.03N, good storage and transportation performance, and it is an ideal high-quality and large-fruit strawberry variety for strawberry production and cultivation. Xiaobai strawberry has the highest sugar and acid ratio and vitamin C content, which were 16.28 and 82.52 mg•100g⁻¹, respectively. Taikong 2008 strawberry showed better performance in soluble solids and flavonoids, 10.60% and 49.17 mg/100g, respectively, superior to the other 6 varieties. Jiaoji has the highest total phenol content, 222.69 mg/100g. Shengdanhong has the highest hardness of 2.13N, but its single fruit weight is only 13.70g. Zhangji performed moderately in terms of single fruit weight, vitamin C, soluble solids, flavonoids, total phenols, and anthocyanins, but its hardness was low, 1.85N, which was not conducive to long-distance transportation.

INTRODUCTION

Strawberry (*Fragaria ananassa* Duch), a perennial herb, belongs to the genus Strawberry of Rosaceae, and is a small berry with high economic value. Strawberry fruit is rich in nutrients such as organic acid, protein, pectin, vitamin C and phenols. It has bright color, sweet and sour taste and unique flavor [1-2]. It has high nutritional value and medicinal and medical value, and can prevent or reduce lung disease. The occurrence of cardiovascular, tumor, gastrointestinal and anemia diseases has been hailed as a "cheap health product" abroad [3].

Since the 1980s, the strawberry industry in China has been developing rapidly. By 2012, the cultivated area of strawberry in China had reached 10×10^4 hm², which became the largest country in strawberry cultivation area, and the strawberry yield also ranked first in the world, reaching 276×10^4 t. The main production areas are located in the eastern coastal areas. Strawberry varieties are also becoming more and more widely cultivated.

Hanyuan County, Ya'an City, Sichuan Province is located in the eastern margin of Hengduan Mountain range. The terrain is mainly mountainous, between 550 meters and 4021 meters above sea level. Hanyuan County is a subtropical monsoon humid climate, warm summer, clear seasons, large vertical climate change, abundant sunshine, abundant light and heat resources. It is suitable for all kinds of fruits and vegetables cultivation, and the quality is good.

Strawberry in Hanyuan County has a short cultivation history and belongs to the typical small-scale cultivation concentrated in the suburbs with relatively single varieties and lack of cultivation and breeding experience of good varieties. Therefore, it is imperative to select new varieties with good quality and high yield which are suitable for local environment and have strong resistance to stress. The quality of seven newly introduced strawberry varieties in Hanyuan was determined and analyzed. Therefore, it provides a theoretical basis for breeding improved strawberry varieties suitable for climate production, cultivation and market adaptation in Hanyuan.

MATERIALS AND METHODS

Test Material

Seven strawberry varieties, such Hongyan, Zhangji, Xiaobai, Jiaoji, Zuixia, Shengdanhong and Taikong 2008, were selected from Hanyuan Strawberry Base, Yaundefinedan City, Sichuan Province. Strawberry with full maturity, uniform size and no pests and mechanical damage was selected at random. 10 fruits were picked from each variety and transported back to the laboratory immediately after harvest for quality analysis. The experiment was repeated three times.

Test Content

The fruit size, fruit weight, fruit hardness, soluble solids content, organic acid content, vitamin c content, anthocyanin content, total phenol content and flavonoid content were determined.

Data Statistics and Analysis

The statistical analysis was carried out by Excel 2010 software SPSS 20.0, and the difference was significant compared with the new complex difference method of Duncan.

RESULTS AND ANALYSIS

Sensory Quality Analysis of Different Strawberry Varieties

As shown in Table 1, there are significant differences in sensory quality among different varieties of strawberries. In terms of single fruit weight, Hongyan had the largest weight, reaching 19.65 g, followed by Taikong 2008, Shengdanhong was the smallest, which was only 13.70 g. The horizontal diameter of Hongyan was 3.31 cm longer than that of other varieties, followed by Xiaobai, with a diameter of 3.26 cm, significantly higher than Zhangji, Jiaoji, Zuixia and Shengdanhong, Jiaoji had the smallest diameter of 2.69 cm., significantly smaller than the other 6 varieties. Jiaoji fruit has the largest longitudinal diameter of 5.35 cm, which was significantly higher than other varieties, the next Zuixia and Zhangji, which were 4.22 cm and 4.10 cm, respectively. The vertical diameter of Shengdanhong was the smallest, only 3.32 cm. In terms of fruit firmness, Shengdanhong has the highest hardness, reaching 2.13 N, followed by Hongyan (2.03 N) and Jiaoji (2.02 N), respectively. There was no significant difference among them, but they were significantly higher than Taikong 2008, Zhangji and Zuixia. Taikong 2008 and Zuixia have the lowest hardness, with only 1.59 N and 1.66 N, significantly lower than the other five varieties.

TABLE 1. Sensory quality Analysis of different Strawberry varieties

Variety	Single fruit weight/g	Fruit diamete/cm	longitudinal diamete/cm	Fruit hardness/N
Hongyan	19.65±0.65 ^a	3.31±0.40 ^a	3.94±0.60 ^{cd}	2.03±0.05 ^{ab}
Taikong 2008	18.56±0.50 ^a	3.21±0.36 ^{ab}	3.94±0.60 ^{cd}	1.59±0.04 ^d
Xiaobai	18.14±0.70 ^a	3.26±0.47 ^a	3.79±0.66 ^d	1.91±0.05 ^{bc}
Zhangji	15.28±0.59 ^{bc}	2.88±0.53 ^d	4.10±0.50 ^{bc}	1.85±0.04 ^c
Jiaoji	15.61±0.55 ^b	2.69±0.51 ^e	5.35±1.21 ^a	2.02±0.05 ^{ab}
Zuixia	18.20±0.66 ^a	3.09±0.49 ^{bc}	4.22±0.71 ^b	1.66±0.05 ^d
Shengdanhong	13.70±0.35 ^c	2.96±0.31 ^{cd}	3.32±0.48 ^e	2.13±0.05 ^a

Note: different lowercase letters after the same column data indicate significant difference ($p < 0.05$).

Analysis on Nutritional Quality of Different Strawberry Varieties

Anthocyanins, vitamin C, soluble solids, organic acids, flavonoids and total phenols have great effects on the quality of fruits and vegetables. As shown in Table 2-4, there are significant differences in nutritional quality among different varieties of strawberries.

As shown in Table 2, the content of soluble solids in Taikong 2008 was the highest (10.60%), followed by Hongyan, Zhangji and Jiaoji (10.01%, 9.43% and 9.41%, respectively). There was no significant difference among the three cultivars, but all of them were significantly higher than that of Zuixia, The soluble solids content of Zuixia the lowest, only 8.65%. As shown in Table 2a, there was no significant difference in organic acid content among the seven cultivars. As shown in Table 2, there is no significant difference in the ratio of sugar to acid among the seven varieties. Xiaobai had the highest ratio of sugar to acid (16.28%), followed by Hongyan (14.28%), Shengdanhong had the lowest sugar to acid ratio of 11.62%. On the content of vitamin C.

TABLE 2. Soluble solids content, solid acid ratio and organic acid content analysis of different strawberry varieties

Variety	Soluble solids content / (%)	Solid acid ratio	Organic acid content / (%)
Hongyan	10.01±0.22 ^{ab}	14.24±0.33a	0.70±0.02a
Taikong 2008	10.6±0.22 ^a	13.89±0.48a	0.76±0.02a
Xiaobai	9.04±0.32 ^{cd}	14.73±3.92a	0.61±0.12a
Zhangji	9.43±0.20 ^{bc}	13.94±0.71a	0.68±0.01a
Jiaoji	9.41±0.17 ^{bc}	13.70±1.10a	0.69±0.04a
Zuixia	8.65±0.2 ^{6d}	13.38±1.81a	0.65±0.13a
Shengdanhong	8.80±0.29 ^{cd}	11.53±0.93a	0.76±0.04a

As shown in Table 3, the content of Xiaobai was the highest, reaching 82.52 mg/100g, followed by Hongyan, Shengdanhong, Taikong 2008 and Zhangji, 74.70 mg/100g, 68.03 mg/100g, 67.78 mg/100g and 67.57 mg/100g, respectively, there was no significant difference in vitamin C content among the four varieties, but all of them were significantly higher than Jiaoji and Zuixia. As shown in Table 3, the anthocyanin content of Hongyan was the highest (67.39 mg/100g), followed by Zuixia and Shengdanhong (66.48 mg/100g and 61.96 mg/100g respectively). The difference among them was not significant, but it was significantly higher than that of the other four varieties. Jiaoji had the lowest anthocyanin content, only 39.32 mg/100g.

TABLE 3. Vitamin C content and Anthocyanin content analysis of different strawberry varieties

Variety	Vitamin C content / (mg 100g ⁻¹ FW)	Anthocyanin content / (mg 100g ⁻¹ FW)
Hongyan	74.70±1.82 ^{ab}	67.39±7.02 ^a
Taikong 2008	67.78±4.78 ^b	47.88±5.29 ^b
Xiaobai	82.52±4.45 ^a	46.93±0.23 ^b
Zhangji	67.57±0.47 ^b	41.05±1.45 ^b
Jiaoji	51.46±7.87 ^c	39.32±0.77 ^b
Zuixia	43.37±2.70 ^c	66.48±3.99 ^a
Shengdanhong	68.03±1.16 ^b	61.96±1.46 ^a

As shown in Table 4, Jiaoji content of total phenol was the highest, reaching 222.69 mg/100g, followed by Shengdanhong, Zuixia, Zhangji and Hongyan. There was no significant difference among the five varieties. The total phenol content of Taikong 2008 was the lowest, with only 144.99 mg/100g. In terms of flavonoid content, as shown in Table 4, there was no significant difference among the seven cultivars. The flavonoid content of Taikong 2008 was the highest, reaching 49.17 mg/100g, the next Hongyan, the content is 44.66 mg/100g, The flavonoid content of Xiaobai was the lowest, which was only 25.35 mg/100g.

TABLE 4. Total phenol and total flavonoids analysis of different strawberry varieties

Variety	Total phenol content / (mg 100g ⁻¹ FW)	Total flavonoids content / (mg 100g ⁻¹ FW)
Hongyan	166.21±24.80 ^{ab}	44.66±5.81 ^a
Taikong 2008	144.99±27.68 ^b	49.17±11.63 ^a
Xiaobai	147.92±17.18 ^b	25.35±2.72 ^a
Zhangji	173.69±13.46 ^{ab}	39.13±3.03 ^a
Jiaoji	222.69±10.58	39.45±9.96 ^a
Zuixia	196.39±4.36 ^{ab}	37.19±5.42 ^a
Shengdanhong	199.94±7.05	34.03±5.88 ^a

RESULTS AND DISCUSSION

Strawberry is a popular fruit with bright color and rich nutrition [4]. In recent years, there are more and more new strawberry varieties, but not every strawberry variety adapts to the new cultivated land. The fruit quality performance of seven strawberry varieties in Hanyuan was measured and analyzed in this experiment. It was found that the average single fruit weight, soluble solids and vitamin C content of Hongyan were higher than that of Zhangji, and there was no significant difference in organic acid content between them. Single fruit weight can reflect the yield to a certain extent. Vitamin C, anthocyanins, flavonoids and other substances in fruits and vegetables are natural antioxidants, which is beneficial to human health. In these seven varieties, the fruit of Hongyan strawberry is big, and it can be used as the main cultivar in Hanyuan area, especially in the content of soluble solids, vitamin C, anthocyanins and flavonoids. Zhangji has low hardness and soft fruit, and other quality traits are medium. It is suggested to produce and sell locally.

In this experiment, the single fruit weight, transverse diameter and soluble solids content were all lower than those of Hongyan, indicating that the characters of Shengdanhong cultivated in Hanyuan region were poor. There was no significant difference in hardness between the two cultivars. The results of Zuixia on single fruit weight and soluble solids were different from those of Huang Haisheng [5] and so on, which might be related to cultivation techniques and climatic conditions. Therefore, these two varieties were not recommended for production and cultivation as popularized varieties in Hanyuan.

Vitamin C is a nutritional ingredient that is very important to human health. The ratio of sugar to acid is closely related to the sweetness of fruit and is also an important index to evaluate the quality of fruit. Total phenol is an important material base of strawberry antioxidant. The antioxidant function of total phenol can prevent chronic diseases such as cardiovascular and cancer. Among the seven varieties, Taikong 2008 strawberry has the highest content of soluble solids and flavonoids. Xiaobai has the highest vitamin C content and sugar acid ratio, the sweet fruit and the highest total phenol content of Jiaoji. But the comprehensive performance of these three varieties in other quality characters is not outstanding, and the three varieties have less data on quality research, so it is impossible to compare their cultivation adaptability in Hanyuan. It is suggested that the three varieties should be used as sightseeing picking in a small amount of development around the urban area. The adaptability of strawberry varieties should be studied not only from sensory and nutritional traits, but also from growth traits, yield and disease resistance.

ACKNOWLEDGEMENTS

Supported by the Natural Science Foundation of China (No. 31801817) and Key Projects of Sichuan Provincial Education Department (No. 172A0319).

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