Evaluation and Exploration of Citrus Germplasm Resources in the Origin of Shatangju (*Citrus flamea* Hort. ex Tseng Shiyueju)

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Abstract [**Objectives**] To protect the local rare citrus germplasm resources and further develop and cultivate new citrus varieties. [**Methods**] The germplasm resources of Shatangju (*Citrus flamea* Hort. Ex Tseng Shiyueju) in Sihui City of Guangdong Province and other 8 citrus varieties from the same origin were evaluated. The appearance characteristics of tree shape, the length and thickness of shoot at each shoot stage, the appearance characteristics of leaves and the fruit quality of each variety were investigated. [**Results**] Through the comparison of various citrus varieties grafted with sour mandarin, the results showed that the overall advantages of the length and thickness of the shoots of Shatang tangerine in summer and autumn were more prominent, which was conducive to fruit setting. The sprouting time of the three shoots of each variety was different, and there were sporadic sprouting phenomena in different seasons, so the growth was different, and the length and thickness of the shoots were different in different seasons. There were significant differences in shoot length and diameter among different varieties in the same season. The coefficient of variation of Shatangju's leaves was low, and the traits were stable; leaf shape, leaf base shape, leaf margin and other indicators among the three shoots of the same variety and the differences among the same shoots of different varieties were compared. All varieties had strong flavor, separately sweet and sour, sweet and sweet taste. Shatangju has many segments, orange pericarp, rough texture, easy peeling, and high oblate fruit shape. The orange pericarp was favored by the participants, while the rough and thick peel was not favored by the participants. [**Conclusions**] Based on the improvement of local varieties, it is recommended to improve the smoothness of pericarp, reducing the thickness of pericarp and improving the flavor of fruit will be conducive to increasing sales. In the cultivation process of various quality resources, especially in the period of fruit growth and development, the plan of nutrition and fertilization should be formulated according to the rules of fruit growth and development, the rules of yield formation and the rules of quality composition, so as to establish the integrated nutrient management system of various varieties.

Key words Shatangju (*Citrus flamea* Hort. ex Tseng Shiyueju), Germplasm resources, Evaluation, Zhaoqing City

1 Introduction

Shatangju (*Citrus flamea* Hort. ex Tseng Shiyueju), also known as October orange, is a farm variety originated from 7 villages of Shatangkeng, Huangtian Town, Sihui City, Zhaoqing, Guangdong Province. At present, it is mainly produced in: Guangxi Zhuang Autonomous Region: Cangwu County in Wuzhou City, Guilin, Baise (Xilin Shatangju), Yangshuo, Lipu, Yongfu, Lingui, Quanzhou Mengshan, Jinxiu, Pingle, Zhaoping, Xiangzhou, Pingnan; Guangdong Province: Huaiji, Guangning, and Sihui. Its fruit is oblate, with tubercle protuberance on the top, the navel end of the pedicle is sunken, the color is orange, pericarp is thin, crisp and tender, and it is easy to peel off the pulp juice and residue[1]. Shatangju has the shape index of 0.78, a single fruit weight of 62 - 86 g, an edible rate of 71%, a soluble solids content of 14%, a total sugar 10.55 g and a fruit acid 0.35 g per 100 mL, belonging to a fruit with high sugar, low acid and rich Vc content[2]. Shatangju is sweet and sour in taste and warm in nature, and has the effects of moistening the lung and clearing the intestines, regulating qi and resolving phlegm, enriching the blood and strengthening the spleen.

Guangdong Province is a main citrus producing area, of which Zhaoqing is the largest in Guangdong Province. By the end of 2008, the planting area of citrus in the whole city was 58 ha, and the output was 61.18 million t[3]. The origin of Shatangju is Sihui City, belonging to the south subtropical monsoon climate. The geographical location of Sihui City (112° 733 773′ E and 23°326 504′ N) is 12 m above sea level. Sihui City is located in the south of the Tropic of Cancer, with an annual average temperature of 21.3 ℃. The annual average rainfall is 1 803.6 mm, the five-year average sunshine is 1 702.3 h, and the annual average thunderstorm days are 89 d. The soil is mainly mountain yellow soil and lateritic red soil. The climate and soil conditions of Sihui are suitable for citrus cultivation.

Biological germplasm resources are the strategic resources for the survival and development of human society, the important guarantee for maintaining national food security, and the material

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basis for biological evolution, genetics research and breeding[4-5]. As one of the provinces with the largest citrus planting area and the largest yield in China, Guangdong Province has far less research on citrus germplasm resources than Hunan, Hubei and Chongqing. Since it was named "Guangdong Biological Germplasm Resource Bank – South Subtropical Fruit Tree Germplasm Resource Bank" in 2005, Guangdong Province has significantly improved in staffing, facilities and many other aspects. The fruit varieties studied in Guangdong Province mainly include subtropical fruits such as litchi, longan, citrus, pineapple and mango, and citrus is also included. Zhaoqing, as the largest citrus producing area in Guangdong Province, has many citrus varieties with a long history, among which Shatangju is a main variety in Guangdong Province originating in Sihui. In the planting peak in 2004, the planting area of Shatangju in Sihui reached 14 500 ha, the total output reached 90 000 t, and the output value was 630 million yuan, accounting for 25% of the total agricultural output value of the city. It was sold to all parts of the country and became a major pillar industry in the city[6-8]. In addition, there are many citrus varieties spreading in Sihui, and some of them are on the verge of extinction with the acceleration of industrialization. In this study, we investigated several citrus germplasm resources originating in Sihui, preserved and evaluated them in order to enrich citrus germplasm resources and improve citrus varieties.

2 Materials and methods

2.1 Materials The adult trees, leaves and fruits of 9 citrus varieties of Shatangju (*Citrus flamea* Hort. ex Tseng Shiyueju), Mashiju (*Citrus flamea* Hort. ex Tseng Mashiju), Bayueju (*Citrus flamea* Hort. ex Tseng Bayueju), Hanggan (*Citrus haniana* Hort. ex Tseng Hanggan), Chazhigan (*Citrus haniana* Hort. ex Tseng Chazhigan), Gonggan (*Citrus nobilis* Lour Gonggan), Lanhuacheng (*Citrus sinensis* Osbeck Lanhuacheng No. 4), Sihuimiju (*Citrus flamea* Hort. ex Wuyueju), and red pulp Gonggan were provided by Sihui Citrus Germplasm Resource Bank and Citrus Research Base of Fruit Tree Research Institute of Zhaoqing University.

2.2 Method for detecting internal and external qualities of tree shape, shoots, leaves and fruits of citrus

2.2.1 Description of the botanical characteristics of citrus. Ten branches of different citrus varieties were randomly selected and numbered, and the length and thickness of spring, summer and autumn shoots were measured with a ruler. Ten leaves were randomly selected for numbering according to the positions of spring, summer and autumn shoots in turn, and measured the leaf length, leaf width, petiole length, wing leaf length, and wing leaf width with a vernier caliper. Ten fruits of each variety picked in December were randomly selected to measure the transverse diameter, longitudinal diameter and pericarp thickness; the shape index was calculated; the weight of a single fruit was weighed by a tray day with an accuracy of 0.01 g. Ten samples were randomly selected to determine the following indicators: the tree shape, tree posture, leaf shape, wing leaf presence, wing leaf shape, leaf base shape, leaf tip shape, leaf tip concave-convex, leaf margin, fruit surface color, fruit surface smoothness, oil cell concave-convex, fruit shape, fruit base shape, fruit navel presence, fruit top hard ring presence, peeling difficulty, central column plumpness, segment number, flesh color, seed number, exotesta color, endotesta color, and embryo type, *etc.*

2.2.2 Fruit quality detection. Ten fruits of each variety were randomly selected and sent to the citrus orchard base Fruit Tree Research Institute of Zhaoqing University for fruit appearance identification and endoplasm analysis. Soluble solids were determined by refractometer, total acids by sodium hydroxide standard titration and total sugars by 3, 5-dinitrosalicylic acid (DNS) colorimetry.

2.2.3 Fruit quality identification. Ten participants were randomly selected to evaluate the appearance and internal quality of 8 citrus varieties grafted by Sour Mandarin picked in December: red pulp Gonggan, Gonggan, Hanggan, Mashiju, Lanhuacheng, Shatangju, and Sihuimiju. During the test, in order to avoid the psychological resistance caused by excessive consumption, participants paid for each variety to taste a piece of flesh, filled in the evaluation form, rinsed their mouths and tasted a piece of flesh of the next variety, and so on until all varieties were tasted. If the participants said that they ate too fast and did not feel the taste, they could add another piece of flesh of this variety to the participants, which did not occur in this experiment.

3 Results and analysis

3.1 Comparison of spring, summer and autumn shoots of nine citrus cultivar grafted on sour mandarin under natural conditions On the premise that the natural environment is suitable and consistent, the control of short summer shoots and long autumn shoots of adult citrus trees can not only reduce the disease incidence of citrus trees, but also improve the fruit yield. When the length of spring, summer and autumn shoots was the length of autumn shoots > the length of spring shoots > the length of summer shoots, the yield was better. When spring shoots > summer shoots > autumn shoots, it is conducive to the healthy growth of fruit trees to increase the yield of fruit in the current year, and is not easy to break branches. As shown in Fig. 1 and Table 1, the length of summer shoots in 9 citrus varieties grafted by sour mandarin was in the range of 6.01 – 19.31 cm; the length of autumn shoots was in the range of 8.61 – 31.61 cm; the thickness of summer shoots was in the range of 1.52 – 4.78 mm; the thickness of autumn shoots was in the range of 1.25 – 2.42 mm. The autumn shoots of Chazhigan, Shatangju, Mashiju grafted by sour Mandarin were longer than that of summer shoots, and summer shoots were thicker than autumn shoots, which is conducive to supporting fruit setting. The length of summer shoots and autumn shoots of Shatangju was 9.76 and 12.71 cm; the thickness of summer shoots and autumn shoots was 2.17 and 1.81 mm.

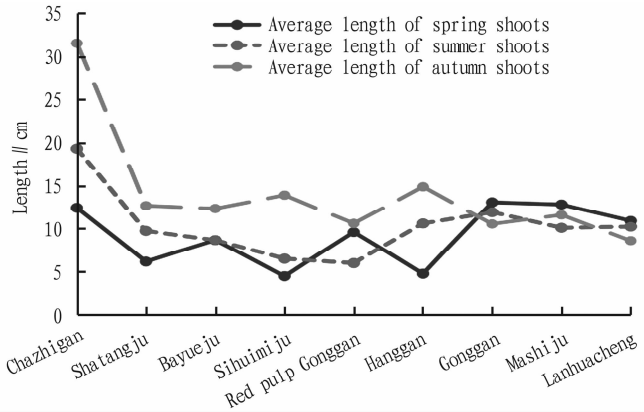

Fig. 1 Comparison of shoot thickness of different varieties at different shoot stage

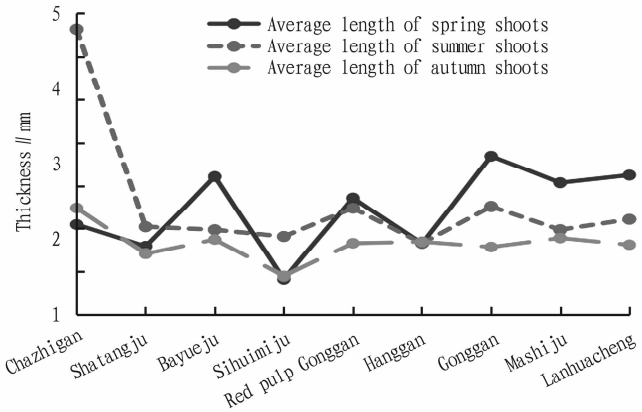

Fig. 2 Comparison of shoot thickness of different varieties at different shoot stage

Table 1 Shoot comparison of sour mandarin grafted citrus varieties

Measurement indicator/variety	Crown shape	Tree posture	Average length of spring shoots // cm	Average length of summer shoots // cm	Average length of autumn shoots // cm	Average thickness of spring shoots // mm	Average thickness of summer shoots // mm	Average thickness of autumn shoots // mm
Chazhigan	Oval	Upright	12.47	19.31	31.61	2.20	4.78	2.42
Shatangju	Oval	Open	6.18	9.76	12.71	1.91	2.17	1.81
Bayueju	Oval	Upright	8.67	8.67	12.38	2.83	2.13	2.00
Sihuimiju	Oval	Droop	4.52	6.52	13.92	1.48	2.04	1.52
Red pulp Gonggan	Oval	Upright	9.62	6.01	10.65	2.55	2.42	1.95
Hanggan	Oval	Upright	4.80	10.64	14.89	1.95	1.95	1.97
Gonggan	Round head	Open	13.10	11.96	10.58	3.10	2.44	1.90
Mashiju	Round head	Open	12.85	10.13	11.64	2.75	2.13	2.02
Lanhuacheng	Oval	Open	10.95	10.27	8.61	2.85	2.27	1.93

Note: crown shape: 1. oblate, 2. round head, 3. oval; tree posture: 1. upright, 2. open, 3. droop.

3.2 Analysis of variance and coefficient of variation of nine citrus cultivars grafted with sour mandarin under natural conditions According to that data analysis in Table 2, the results showed that the leaves of Chazhigan, Shatangju, Bayueju, Sihuimiju, red pulp Gonggan, Hanggan, Gonggan, Mashiju and Lanhuacheng were longer, the significance of indicators of leaf width, petiole, leaf shape index, wing leaf length, leaf length/wing leaf length was less than 0.05, and the difference was significant, so the original hypothesis is valid. The *F* test values of eight citrus varieties ranged from 2.80 to 35.11, and the *F* test value of leaf shape index was the largest, indicating that the differences between varieties were the most significant. The leaf shape index of autumn shoots was particularly prominent, and the *F* test value was as high as 35.11; the *F* test value of wing leaf length had the smallest overall difference, indicating that there was no significant difference between varieties. By comparing the leaf indicators of spring, summer and autumn shoots, the results showed that the *F* test values of leaf length, leaf width, petiole length and leaf shape index of autumn shoots were the highest, and the differences were significant; the *F* test values of wing leaf length and leaf length/wing leaf length of summer shoots were the highest, and the difference was significant.

Table 2 Variance analysis of 9 citrus cultivars grafted with sour mandarin

Trait	Spring shoots		Summer shoots		Autumn shoots	
	F test value	Significance	*F* test value	Significance	*F* test value	Significance
Leaf length	9.75	0.000	12.24	0.000	24.21	0.000
Leaf width	4.04	0.000	3.32	0.002	14.58	0.000
Petiole leaf	7.27	0.000	4.69	0.000	7.66	0.000
Leaf shape index	12.01	0.000	13.36	0.000	35.11	0.000
Wing leaf length	2.86	0.007	5.02	0.000	3.44	0.002
Leaf length/Wing leaf length	2.80	0.009	8.60	0.000	4.03	0.000

Table 3 indicated therelationship between the average coefficient of variation of leaf length/wing leaf length and the coefficient of variation of Shatangju leaf for the leaf length, leaf width, petiole, leaf shape index, wing leaf length of spring, summer, and autumn shoots of leaves of Chazhigan, Shatangju, Bayueju, Sihuimiju, red pulp Gonggan, Hanggan, Gonggan, Mashiju. The results of leaf comparison on spring shoots showed that except the coefficient of variation of leaf length of Shatangju was larger than that of 9 citrus varieties, the other leaf indicators of Shatangju were smaller than the average coefficient of variation, indicating that the leaf traits on spring shoots of Shatangju were relatively stable. The comparison of Shatangju's leaves on summer shoots showed that the coefficient of variation of Shatangju's leaves was smaller than the average coefficient of variation, except that the coefficient of variation of leaf length and leaf shape index was larger than that of nine citrus varieties, indicating that the leaf traits on summer shoots of Shatangju were relatively stable. The comparison of Shatangju's leaves on autumn shoots showed that the coefficient of variation of Shatangju's leaves was smaller than the average coefficient of variation and close to the average coefficient of variation, except that the coefficient of variation of leaf length and leaf width was larger than that of nine citrus varieties, indicating that the leaf traits on Shatangju autumn shoots were relatively stable. The coefficient of variation of Shatangju leaf was low, indicating that the overall level of Shatangju leaf traits was stable.

Table 3 Comparison of coefficient of variation of Shatangju grafted by sour mandarin with average value of coefficient of variation of 9 citrus cultivars

%

Trait	Leaf on spring shoots		Leaf on summer shoots leaf		Leaf on autumn shoots	
	9 citrus cultivars	Shatangju	9 citrus cultivars	Shatangju	9 citrus cultivars	Shatangju
Leaf length	8.48	9.12	11.00	14.76	11.33	15.66
Leaf width	9.74	8.42	13.96	8.65	11.46	12.37
Petiole leaf	23.08	22.00	19.11	11.67	20.83	15.60
Wing leaf length	29.19	15.85	22.35	18.97	25.15	24.51
Leaf shape index	8.33	5.46	10.91	11.00	9.32	8.05
Leaf length/Wing leaf length	29.93	22.56	26.87	14.08	28.29	23.41

3.3 Comparison of fruit external quality traits of 8 sour mandarin grafted citrus cultivars under natural conditions

As shown in Table 4, the segment number of Shatangju fruit of 8 grafted cultivars was 7 – 10, and the segment number of Shatangju and Bayueju was the most (10 petals). Compared with Lanhuacheng, the other fruits were easier to peel; in contrast, the pericarp of Shatangju wasthe coarsest; the pericarp of Mashiju was the darkest in color. According to the results in Table 5, the fruit weight of sour mandarin grafted varieties was in the range of 9 – 121 g, and the average weight of 8 kinds of fruits was 80.884 75 g. The heaviest fruit of Hanggan was 120.56 g, the lightest weight of Mashiju was 9.522 g, and the weight of Shatangju was 70.259 g, which was lower than the average. The shape index of eight kinds of grafted fruits was between 0.77 and 1.02, the larger the shape index, the closer to round, and the smaller the shape index, the closer to oblate. The fruits of Gonggan, red pulp Gonggan and Lanhuacheng were spherical, while the others were oblate. The flesh color of red pulp Gonggan and Lanhuacheng was yellowish white, and the flesh color of the other seven cultivars tended to be orange. The pericarp thickness of the eight fruits ranged from 1.531 to 2.666 mm, and the thickest pericarp of Shatangju was 2.666 mm. The number of seeds of eight fruits ranged from 1 to 16, and the number of seeds of Shatangju was 5, which was lower than the average of 7.5. The seed coat color of the eight fruits tended to be yellow-white, and the inner seed coat tended to be brown. The embryo types of 8 kinds of fruits were all polyembryony. The main characteristics of Shatangju were many segments, orange pericarp, rough texture, easy peeling, and high oblate fruit shape.

Table 4 Comparison of fruit appearance traits of different citrus varieties grafted with sour mandarin

Variety	Fruit surface color	Fruit surface smoothness	Oil bubble	Fruit shape	Fruit base shape	Fruit top shape	Fruit navel	Hard ring at fruit apex	Peeling difficulty	Central column plumpness	Segment number
Bayueju	Yellow-green	Smooth	Concave	High oblate	Flat	Shallow concave	Yes	Yes	General	Cracking	10
Shatangju	Orange	Coarse	Convex	High oblate	Flat	Shallow concave	Yes	Yes	Easy	Cracking	10
Sihuimiju	Yellow-green	Moderate	Concave	High oblate	Flat	Flat	Yes	Yes	Easy	Hollow	9
Red pulp Gonggan	Light orange	Coarse	Concave	Spherical	Round	Flat	Yes	Yes	General	Plump	7
Hanggan	Yellow-green	Moderate	Convex	High oblate	Flat	Flat	Yes	Yes	General	Plump	9
Gonggan	Light yellow	Smooth	Concave	Spherical	Round	Round	Yes	Yes	General	Hollow	9
Mashiju	Deep orange	Smooth	Flat	High oblate	Shallow concave	Shallow concave	Yes	Yes	Easy	Hollow	9
Lanhuacheng	Deep orange	Smooth	Flat	Spherical	Flat	Round	Yes	Yes	Difficult	Cracking	9

Table 5 Comparison of fruit appearance traits of different citrus cultivars grafted with sour mandarin

Variety	Fruit weight // g	Transverse diameter // mm	Longitudinal diameter // mm	Shape index	Pericarp thickness // mm	Flesh color	Number of seeds	Exotesta color	Endotesta color
Bayueju	65.420	47.609	37.471	0.787	1.806	Orange	12	Light yellow	Brown
Shatangju	70.259	52.674	44.299	0.841	2.666	Orange	5	Yellow-white	Tan
Sihuimiju	40.766	43.582	36.852	0.846	2.021	Orange red	3	White	Brown
Red pulp Gonggan	112.341	59.612	57.211	0.962	2.348	Yellow-white	9	Yellow-white	Brown
Hanggan	120.560	63.490	53.954	0.851	2.184	Orange	16	Yellow-white	Tan
Gonggan	116.363	60.897	57.230	0.940	2.169	Light orange	6	Light yellow	Brown
Mashiju	9.522	27.722	21.431	0.775	1.531	Orange red	1	Yellow-white	Brown
Lanhuacheng	111.847	58.379	59.312	1.020	2.100	Yellow-white	8	Yellow-white	Brown

Note: the embryo type of all varieties is polyembryony.

Note: i. Mashiju fruit; j. Lanhuacheng fruit; k. Hanggan fruit; l. Shatangju fruit. The unit of scale is cm.

Fig. 3 Comparison of fruits of Mashiju, Lanhuacheng, Hanggan and Shatangju grafted with sour mandarin

Note: n. Gonggan fruit; m. Sihuimiju fruit; o. red pulp Gonggan fruit. The unit of scale is cm.

Fig. 4 Comparison of fruits of Gonggan, Sihuimiju and red pulp Gonggan grafted with sour mandarin

3.4 Comparison of internal fruit quality traits of eight citrus cultivars grafted with sour mandarin under natural conditions

As shown in Table 6, the total sugar content of the eight citrus varieties ranged from 7.90% to 11.55%, with Gonggan having the lowest sugar content of 7.90%, Bayueju having the highest sugar content of 11.55%, and Shatangju having a sugar content of 8.91%, which was lower than the average 9.51%. The organic acids of the eight citrus varieties ranged from 0.12% to 2.9%, with the lowest content of 0.12% in Sihuimiju, the highest content of 2.84% in Mashiju, and 0.42% in Shatangju, which was lower than the average 0.66%. Soluble solids of the eight citrus varieties were in the range of 11.2% – 21.0%, with Gonggan having the lowest soluble solids content of 11.2%, Mashiju having the highest soluble solids content of 21%, and Shatangju having a soluble solids content of 13.0%, which was lower than the average value of 13.8%. The content of total sugar, organic acid and soluble solid of Shatangju were below the average of eight citrus varieties, while the content of total sugar, organic acid and soluble solid of Mashiju were significantly higher than other varieties.

Table 6 Comparison of internal characters of different citrus varieties grafted with sour mandarin %

Variety	Total sugar	Organic acid	Soluble solids
Shatangju	8.91	0.42	13.0
Mashiju	10.98	2.84	21.0
Sihuimiju	8.92	0.12	13.7
Hanggan	8.69	0.56	11.9
Lanhuacheng	10.35	0.36	16.2
Red pulp Gonggan	8.81	0.35	12.0
Gonggan	7.90	0.28	11.2
Bayueju	11.55	0.47	11.6

3.5 Comparison of internal fruit quality traits of eight citrus cultivars grafted with sour mandarin under natural conditions

As shown in Table 7, the total score of fruit evaluation was in the range of 60.15 – 77.5 points, the lowest score was Mashiju 60.15 points, the highest score was Lanhuacheng 77.5 points, the total score of Shatangju was 73.45 points, and Shatangju was higher than the average score of 71.41 points. Mashiju, with the lowest total score, had lower internal and external indicators, especially fruit size, flesh quality and seeds, which were only 4, 5.4 and 5 points, respectively. Lanhuacheng, which had the highest total

score, had higher internal and external indicators, separately 8.1, 8.8, 8.7 and 8.05 points of meat quality, juice and flavor, which were significantly higher than those of other citrus varieties. Shatangju's orange pericarp was more popular with participants and received the highest score of 9 points. According to the reactions of the participants, Mashiju is characterized by small fruit, sour juice and rich fruit flavor; Lanhuacheng is characterized by high water content and sweet juice; Shatangju is characterized by good color and sweet taste.

Table 7 Comparison of evaluation of different citrus varieties grafted with sour mandarin

Sample No.	Average score of appearance evaluation (50 points)					Average score of internal quality evaluation (50 points)					Total score (100 points)
	Fruit shape	Size	color and luster	Pericarp thickness	Uniformity	Pericarp thickness	Flesh	Juice	Seed	Flavor	
1	6.75	8.10	6.50	6.60	7.10	6.75	7.75	8.45	8.35	7.85	74.20
2	7.65	8.15	6.05	7.45	6.95	7.60	7.80	8.25	7.15	7.80	74.85
3	7.40	7.20	6.25	6.25	9.25	7.00	6.05	5.45	5.95	5.40	66.25
4	6.10	4.10	6.80	6.35	7.75	6.10	5.40	5.00	6.05	6.20	60.15
5	7.35	7.15	7.15	6.85	7.75	7.85	8.10	8.80	7.80	8.70	77.50
6	7.75	7.85	9.00	6.30	7.70	6.80	7.45	7.35	6.25	7.25	73.45
7	7.55	7.60	6.25	7.65	8.30	8.05	7.15	7.00	7.90	6.30	73.45

Note: 1. Red pulp Gonggan, 2. Gonggan, 3. Hanggan, 4. Mashiju, 5. Lanhuacheng, 6. Shatangju, 7. Sihuimiju. Each indicator has a score of 10 points.

4 Discussion

People generally judge Shatangju fruit directly by its appearance, which includes fruit size, shape, pericarp thickness, uniformity, fruit smooth finish and pericarp color. After China's accession to the WTO, not only higher requirements are put forward for the appearance quality of citrus, such as the export of high-quality citrus requires consistent fruit size, neat appearance, thin and smooth pericarp, pericarp inherent color and luster, but also puts forward requirements for Vc content, fruit aroma, flavor, residue and other internal quality[10]. According to reports, seedless Shatangju is characterized by oblate fruit, flat top, concave top line, orange-yellow flesh, sweet taste, rich juice, orange-red pericarp, thin and crisp, strong aroma, less fiber, slightly smaller fruit, average fruit weight of about 40 g, fruit longitudinal diameter of 3.6 – 4.3 cm, the transverse diameter is 4.0 – 5.5 cm, and the average number of seeds per fruit is less than 0.5[2]. The results showed that the fruit of Shatangju isexcellent, that is, the fruit is oblate, the top was flat, the pericarp is orange, the flesh is orange, the taste is sweet, and the fiber is less. The tested Shatangju is a variety with seeds, and the seedless Shatangju is selected by bud mutation on this basis, and the seedless variety retains the flavor of Shatangju. Mashiju has unique flavor, high content of total sugar, significant content of organic acid and soluble solids. The reason for its low quality evaluation score is that its acidity is too high and it has seeds, which leads to poor palatability. However, seedless varieties can be considered in the development and application, and combined with its characteristics of high sugar and acid, it can be developed and applied as a processing variety. Using Shatangju for hybrid breeding, there have been successful cases in China, such as Jinqiu Shatangju. In addition, in the cultivation process of various quality resources, especially in the period of fruit growth and development, it is recommended to formulate the plan of nutrition and fertilization according to the rules of fruit growth and development, the rules of yield formation and the rules of quality composition, so as to establish an integrated nutrient management system of various varieties, which also needs to be further studied and discussed[11].

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