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Research Article

Style Characteristics Investigation of Quan-Xing Baijiu by Comparing Other Strong-Aroma Baijiu Brands in China

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Quan-xing Baijiu, a famous brand with different style characteristics from traditional strong-aroma Baijiu, is considered superior due to its "jiao-xiang" (caramel) flavor and the "he-run" (soft, moistening, and harmonious) style. In this study, gas chromatography-olfactometry (GC-O) was used to analyze the special flavors of Quan-xing Baijiu. The flavor fingerprints of six traditional strong-aroma Baijiu were determined using fragrance, taste, and entirety style in order to establish the individual style of Quan-xing Baijiu. The results indicated that 3-methyl butanol, ethyl butyrate, ethyl hexanoate, ethyl acetate, and ethyl caprylate were the main important aroma compound, which contributed to the he-run style in Quan-xing Baijiu. A standard of Quan-xing Baijiu's typical style was established by flavor fingerprint. Together with the concordance rate evaluation method, this standard can help determine the characteristics of Baijiu samples for quality control. A rate above 81% represents a typical product staleness and good stability, while a rate below 73% represents a nontypical Quan-xing Baijiu product.

1. Introduction

Chinese Baijiu is classed into strong aroma, light aroma, sauce aroma, rice aroma, and so on. Strong-aroma Baijiu occupies more than 70% of the whole Chinese Baijiu market. According to the region and Baijiu styles, strong-aroma Baijiu can be divided into different genres, including the Sichuan genre, the Jianghuai genre, and the Northern genre. The Sichuan genre was the origin of strong-aroma Baijiu. Half of the high-quality, strong-aroma Baijiu brands were produced in this region, such as Wuliangye, Luzhou laojiao, Jiannanchun, Quan-xing daqu, Tuopai, and other famous brands [1].

Quan-xing daqu Baijiu belongs to the Sichuan genre, and its production base is located in the northwestern of the Sichuan basin. The fertile land and mild climate in this area give it the name "the hometown of vintage wine." In the brewing process of Chinese Baijiu, steamed, high-quality sorghum was used along with medium-temperature daqu and was added into traditional pits for fermentation. This kind of fermentation in a traditional pit can produce enough esterification to enrich the flavor of the final product. After fermentation, the wet fermented grains were mixed with a certain percentage of fresh grains for medium-temperature distillation. Different qualities of Baijiu products were stored in separate jars after distillation, while blending and other processes would be applied to make the final product. Previous studies have shown that the style was different among all strong-aroma Baijiu of the Sichuan genre. For instance, Wuliangye is famous for its fragrance, full taste, and harmony. Luzhou laojiao is characterized by being mellow, rich, clean, and sweet, with a delicate aftertaste. The taste of Jiannanchun is ageing, clean, and mellow [1, 2]. As one of the eight famous Baijiu, Quan-xing daqu Baijiu is colorless with a limpid, glittering, translucent, aroma rich, sweet, clean and delicious taste [3]. It uses two kinds of daqu, one named Tao-hua qu and the other named Fu-qu. Tao-hua qu is produced in the peach blossom season, with an average temperature, while Fu-qu is produced in the summer, with a high temperature. When daqu is used for brewing, the

method uses half Tao-hua qu and half Fu-qu, which is the main technological point to distinguish other similar types of Baijiu [4].

The traditional method to determine the style characteristics of spiritual products relied on the sensory taste of professionals and technical personnel. Sensory tasting could reflect the style characteristics of products, but the analysis of featured flavor compounds requires quantitative analysis [5]. For example, the content of ethyl caprylate in Chinese Baijiu is low, but through quantitative analysis, it plays a strong role in the style characteristics of the product [6]. Therefore, gas chromatography-olfactory (GC-O) is introduced in this study. GC-O is a precision instrument for flavor analysis and has been used in the food industry in recent years [7, 8]. It separates the flavor compounds of Chinese Baijiu, and determines its aroma characteristics and intensity by odor [7, 9–13]. An analysis of the characteristics of fragrance and food taste was established by flavor fingerprint technology (odor) used by Chinese Baijiu production companies. The data obtained by GC-O analysis can be applied to flavor fingerprint technology, which can not only reflect the analysis of a special aroma of Chinese liquor but also reflect the description of product style, allowing convenient communication with consumers [14]. It will contribute to Chinese Baijiu-producing companies to better realizing the trend of market consumption and developing high-quality products [15–17].

In this study, GC-O was used to analyze the important flavors of Quan-xing daqu Baijiu and determined the main aroma compounds which represent the individual style of Quan-xing daqu Baijiu [18, 19]. The analysis technologies of flavor fingerprint were also applied to establish a new assessment method of the concordance rate for the style of Quan-xing daqu Baijiu [20].

2. Materials and Methods

2.1. Materials. (1) Sichuan Quan-xing Co., Ltd. offered approximately 20 typical liquor base samples for GC-O analysis. (2) Sichuan Quan-xing Co., Ltd. offered Quan-xing daqu, Mengzhilan, Wuliangye, Jiannanchun, Guojiao, and Shuijingfang, which are all end products with an alcoholic strength of 52% vol. In order to carry out the GC-O analysis to establish the flavor fingerprint, labels *A*, *B*, *C*, *D*, and *E* were used for these Baijiu products, except Quan-xing daqu. (3) Sichuan Quan-xing Co. Ltd. offered approximately 120 Baijiu base samples to establish the concordance rate of this method.

2.2. Test Instrument. Except for regular experiment instruments like a graduate cylinder, a separating funnel, a pH meter, etc., gas chromatography (GC) from PerkinElmer company was also used in this study. The GC model is Autosystem XL, equipped with an FID detector, a DB-Wax ETR 0.53 mm × 30 m chromatographic column, and an olfactory port. The injector temperature was set at 240°C, and the detector temperature was set at 270°C. Nitrogen (99.99%) was used as a carrier gas at a flow rate of 8 mL/min. Temperature program for chromatographic analysis is initial temperature 38°C, then increase to 200°C at a rate of 15°C/min, maintained for 10 min.

2.3. GC-O Analytical Method. GC-O is an effective method for selecting and evaluating the active flavor substances in a complicated mixture. Besides the gas chromatograph, GC-O is also equipped with an Olfactory Detection Port (ODP) (Focus Tech, Shenzhen). The sample was injected directly, and after sample injection and stratification through chromatography, gas samples were split and went into FID and ODP following 1 : 1 ratio. By this method, the same flavor compounds were detected simultaneously by FID detector and sniffer personnel, thus establishing the relation between the compound and its fragrance. For analysis, the following five-mark scoring systems were applied: 0-nonentity;1-very slight; 2-slight;3-clear;4-remarkable;5-very remarkable [10].

In chromatographic analysis, 1 μL of the sample was directed and injected for GC-O analysis. The smell analysis was performed by an eight-member Baijiu tasting expert panel (five men and three women, between 25 and 45 years old), of which two were universally trained China Baijiu judges. The tasters determined the smell according to a standard technological process; the retention time, aroma strength, and description of the fragrance were recorded. The result of the smell analysis was an average value. According to the retention times of different flavor compounds, accurate characterization was made [7, 8].

2.4. Flavor Fingerprint Analysis Method. The analysis chart of the flavor fingerprint was first established in this study by combining the analysis result from the GC-O and numerated description. The GC-O analysis summarized the flavor characteristics of the flavor components in Quan-xing daqu Baijiu, and the numerated description included the following parameters: ester flavor, mellow flavor, jiao-xiang (caramel) flavor, multiple-grains flavor, and mud taste.

On this basis, some characteristic samples were tasted by the tasters for the final determination of the typical flavor of Quan-xing daqu. Description of the typical flavor includes the following parameters: ester, mellow, jiao-xiang (caramel), qu-xiang (starter), single-grain, multiple-grains, sesame, anxious burnt, spoiled milk, potpourri, aldehyde, chen-xiang (ageing), kang (rice husk), zao (jujube), mud, sulphur, sour, bitter, astringent, biting, chun-tian (ethanol and sweet), remaining, new wine, old wine, Shuang-jing (clean), lasting, soft-sweet, fullness, coordinating, and he-run (soft, moistening, and harmony).

The "flavor fingerprint" marking table was set up for Quan-xing daqu based on the feature flavor descriptors that had previously been decided. The marking standard was: 0—insipidity; 1—could be perceived slightly but be difficult to identify; 2—very light; 3—lighter; 4-5—medium;6-7—stronger;8-9—leading [21]. About 8 tasters took part in the analysis and marked the samples, which determined the flavor fingerprint.

3. Results and Discussion

3.1. Interpretation of GC-O Results. According to the analysis of the results in Table 1, 18 kinds of flavor compounds could be detected and smelled through direct injection. It revealed that alcohols, esters, and acids were the most important fragrant flavor components in Quan-xing daqu Baijiu, which is similar to previous reports [5, 22, 23]. The major smelled esters were isoamyl acetate, ethyl hexanoate, ethyl caprylate, ethyl acetate, and ethyl oenanthate, in which ethyl hexanoate was the main body flavor and other esters were all principal ester flavor components in Quan-xing daqu. The major smelled fatty acids included ethyl butyrate, 2-methylbutyric acid, caproic acid, and acetic acid, and the major alcohols included normal propyl alcohol, 2-pentanol, and 2-phenethyl alcohol [7, 24, 25].

These active ingredients discovered in Quan-xing daqu provided an important fragrant effect for the typical style of Quan-xing daqu Baijiu. Besides the flavors brought by each of the major esters, ethyl phenylacetate has a strong, sweet honey flavor. Quan-xing daqu Baijiu contains a significant amount of ethyl butyrate, which imparts a buttery, caseous taste.*N*-propyl acetate has a soft fruity odor, 2-methylbutyric acid brings a buttery taste, cheese, and fruity odor, 4-methylpentanoic acid brings a spissated cheese fragrance, and 2,3-butanedione has a buttery odor in a dilute solution. Phenethyl alcohol is another beneficial active ingredient fragrance in Chinese Baijiu, which brings a rose potpourri odor to the wine body. In line with the analysis results from the GC-O, it can be stated that the main flavor compounds that form the typical style of Quan-xing daqu include 3-methylbutanol, ethyl butyrate, ethyl hexanoate, ethyl acetate, ethyl caprylate, caproic acid, acetic acid, phenethyl alcohol, 2-methylbutyric acid, 4-methyl valeric acid and so on.

3.2. Flavor Fingerprint Analysis. The tasting results of six strongly aromatic Baijiu are shown in Table 2, in which 31 major flavor characteristics were categorized into 3 classes (aroma, taste, and sense of wholeness). In Table 2, there were significant differences in 30 kinds of sensory parameters except mellow among Quan-xing Baijiu and the other five kinds of strongly-flavored Baijiu.

Figures 1(a)–1(c) show the differences in flavor features of the 6 strong-aroma Baijiu included in this analysis. Specifically, the scores of these 6 Baijiu were very close on mellow, potpourri, qu-xiang, and chen-xiang odors. The flavor characteristics of bitterness, astringency, new wine taste, and sulphur taste have a negative effect on the wine body, and the scores of these 6 Baijiu on such parameters were lower. This illustrated that these six products were both high-quality products of strong-aroma Baijiu. The objective product Quan-xing daqu Baijiu was obviously different from the others in "two fragrances": potpourri and sesame flavor, and "four tastes": chun-tian (ethanol and sweet) taste, lasting sense, Shuang-jing (clean) sense, and coordinating sense. These were the sensory bases that form the individual style of Quan-xing daqu Baijiu.

Meanwhile, the scores of these 6 products were respectively higher on 12 characteristic styles: mellow, jiao-xiang (caramel), multiple-grains, chun-tian, remaining, old wine, Shuang-jing, lasting, soft-sweet, fullness, coordinating, and he-run (soft, moistening, and harmony) sense. This reflected the fact that these 12 flavor features could represent the properties of the six strong-aroma Baijiu products and formed the basis of the fingerprint of the strong-aroma Baijiu and the radar map (Figure 1(d)).

Figure 1(d) shows the comparison of the style characteristics of the 6 strong-aroma Baijiu products. The mellowness and fullness senses were close, but the multiple-grains flavor, chun-tian taste, and he-run sense had larger differences. For example, sample *D* was excellent for the old wine taste, and sample *C* achieved a high score on the multiple-grains flavor. Quan-xing daqu Baijiu had an outstanding performance on jiao-xiang, chun-tian taste, lasting sense, soft-sweet sense, and he-run sense. The chun-tian taste, lasting sense, and soft-sweet sense were helpful for determining the he-run sense, and Quan-xing daqu Baijiu was obviously different from other strong-aroma Baijiu products based on the he-run sense.

3.3. Establishing and Applying the Evaluation Method of a Typical Style Concordance Rate. A normal phenomenon discovered in Chinese Baijiu is that, although using the same method, there were differences between spirit products from different manufactured batches. How to evaluate the concordance rate of the body composition and the style of Chinese Baijiu is an important issue to be investigated. At present, the main method of Baijiu-making enterprises relies on chromatographic analysis to determine body composition and to evaluate the quality of spirit by comparing the content and relative abundance of main flavor substances with established standards. The determination of the style characteristics mainly relies on an integral sense of opinions from tasters. The main problem with this method is that the content of flavor components quantified by chromatography is usually very low in Chinese Baijiu, and the determination of style characteristics is subjective and uncertain because of the personal integral sense of spiritual tasters.

To analyze the typical style concordance rate of products more precisely, the analysis techniques of flavor fingerprinting should be used to establish the evaluation method of the typical style concordance rate. In this study, 120 spirit samples provided by Sichuan Quan-xing Co., Ltd. were judged and marked, and 12 flagged value ranges of sense styles were obtained, which could represent the typical style of Quan-xing daqu Baijiu (Table 3). The ranges of the 12 standard scores of sense features were achieved by specialist spirit tasters. They tasted about 120 Quan-xing daqu Baijiu samples scientifically and earnestly. For example, when considering the chun-xiang taste, if the score of the sample was 2.0–2.5, it was likely to have the typical style of Quan-xing daqu Baijiu, but when the score was above 2.5 or below 2.0, the typicality of the style would be influenced. The further away from the standard scores range, the worse the

Table 1: The results of samples tested by GC-O.

RI	Flavor active substances	Fragrance descriptions	Fragrance scores
1018	Ethyl acetate	Fruity	2.5
1021	Ethanol + normal propyl alcohol	Mellow	4.0
1026	Ethanol + diacetyl	Cheese	2.5
1137	Ethanol + isoamyl acetate	Mellow	4.0
1139	2-methyl propanol	Mellow	2.5
1154	2-amyl alcohol	Mellow	3.5
1168	Ethyl hexanoate	Fruity	3.5
1172	2-methylbutanol	Higher alcohols	3.5
1198	3-methylbutanol	Higher alcohols	3.5
1241	Ethyl oenanthate	Meat flavor	2.0
1390	2-heptanol	Unpleasant flavor	2.5
1407	Ethyl caprylate	Fruity, aroma	3.5
1419	Acetic acid	Fermented sour	3.5
1632	Ethyl butyrate	Milk smell	5.0
1719	2-methylbutyric acid	Acidic odor	4.0
1852	Caproic acid	Solvent flavor	3.8
1899	Phenethyl alcohol	Potpourri	2.5
2017	Heptylic acid	Anise	2.0

Table 2: The results of flavor features by sensory evaluation.

Sample	*A*	*B*	*C*	*D*	*E*	Quan-xing daqu	*P* value
(1) Ester flavor	2.10 ± 0.05^{b}	2.45 ± 0.25^{a}	2.10 ± 0.12^{b}	2.10 ± 0.21^{b}	1.85 ± 0.15^{b}	1.85 ± 0.15^{b}	0.002
(2) Mellow	2.23 ± 0.15^{a}	2.41 ± 0.25^{a}	2.42 ± 0.21^{a}	2.46 ± 0.21^{a}	2.28 ± 0.21^{a}	2.25 ± 0.23^{a}	0.444
(3) Potpourri	0.41 ± 0.05^{b}	0.39 ± 0.02^{b}	0.72 ± 0.02^{a}	0.43 ± 0.01^{b}	0.41 ± 0.01^{b}	0.72 ± 0.02^{a}	<0.001
(4) Jiao-xiang	3.59 ± 0.11^{b}	2.81 ± 0.05^{c}	2.63 ± 0.11^{c}	2.42 ± 0.02^{d}	2.61 ± 0.15^{c}	4.10 ± 0.23^{a}	<0.001
(5) Qu-xiang	1.05 ± 0.05^{d}	1.65 ± 0.12^{a}	1.21 ± 0.15^{c}	1.85 ± 0.24^{a}	1.46 ± 0.17^{b}	1.45 ± 0.16^{b}	<0.001
(6) Single-grains flavor	3.21 ± 0.15^{a}	0.21 ± 0.01^{e}	0.22 ± 0.01^{e}	1.09 ± 0.13^{d}	1.29 ± 0.14^{c}	2.10 ± 0.15^{b}	<0.001
(7) Multiple-grains flavor	1.81 ± 0.05^{d}	4.20 ± 0.52^{b}	5.49 ± 0.45^{a}	4.61 ± 0.38^{b}	4.10 ± 0.27^{b}	3.21 ± 0.23^{c}	<0.001
(8) Sesame flavor	0.86 ± 0.05^{c}	1.05 ± 0.13^{b}	0.41 ± 0.01^{e}	0.22 ± 0.01^{f}	0.63 ± 0.02^{d}	1.89 ± 0.15^{a}	<0.001
(9) Aldehyde odor	—	1.25 ± 0.11^{a}	1.08 ± 0.15^{b}	0.21 ± 0.01^{e}	0.85 ± 0.02^{c}	0.45 ± 0.01^{d}	<0.001
(10) Mud taste	0.47 ± 0.02^{a}	0.36 ± 0.01^{b}	—	0.21 ± 0.01^{c}	—	0.49 ± 0.02^{a}	<0.001
(11) Sulphur taste	—	—	—	—	—	—	—
(12) Anxious burnt flavor	—	—	—	—	—	—	—
(13) Spoiled milk	1.05 ± 0.05^{a}	—	—	0.41 ± 0.01^{b}	—	—	<0.001
(14) Chen-xiang odor	0.44 ± 0.01^{c}	0.65 ± 0.01^{b}	0.85 ± 0.02^{a}	0.41 ± 0.01^{c}	0.42 ± 0.02^{c}	0.41 ± 0.02^{c}	<0.001
(15) Kang odor	—	1.05 ± 0.12^{b}	0.43 ± 0.02^{c}	0.24 ± 0.01^{d}	1.65 ± 0.14^{a}	0.45 ± 0.02^{c}	<0.001
(16) Zao odor	1.85 ± 0.05^{a}	1.08 ± 0.12^{b}	0.46 ± 0.01^{e}	0.63 ± 0.02^{d}	0.21 ± 0.01^{f}	0.83 ± 0.02^{c}	<0.001
(17) Sour	0.82 ± 0.02^{b}	1.66 ± 0.10^{a}	0.23 ± 0.01^{c}	—	—	0.22 ± 0.01^{c}	<0.001
(18) Bitter taste	0.42 ± 0.02^{d}	0.64 ± 0.02^{b}	0.23 ± 0.01^{e}	1.45 ± 0.02^{a}	0.55 ± 0.02^{c}	0.21 ± 0.01^{e}	<0.001
(19) Astringent	0.43 ± 0.02^{b}	0.49 ± 0.01^{b}	—	1.28 ± 0.01^{a}	—	—	<0.001
(20) Biting taste	0.64 ± 0.01^{d}	0.83 ± 0.02^{c}	0.62 ± 0.02^{d}	1.05 ± 0.02^{a}	0.95 ± 0.01^{b}	0.43 ± 0.01^{e}	<0.001
(21) Chun-tian taste	4.40 ± 0.27^{b}	2.41 ± 0.22^{d}	4.89 ± 0.12^{a}	3.75 ± 0.25^{c}	5.06 ± 0.51^{a}	4.99 ± 0.17^{a}	<0.001
(22) Remaining taste	5.53 ± 0.17^{a}	4.05 ± 0.27^{c}	3.71 ± 0.18^{d}	3.65 ± 0.37^{d}	4.32 ± 0.11^{b}	4.61 ± 0.13^{b}	<0.001
(23) New liquor taste	—	—	—	—	—	—	—
(24) Old liquor taste	4.45 ± 0.34^{b}	3.61 ± 0.27^{c}	3.25 ± 0.16^{d}	5.16 ± 0.13^{a}	3.63 ± 0.15^{c}	3.56 ± 0.12^{c}	<0.001
(25) Shuang-jing sense	5.45 ± 0.31^{a}	4.06 ± 0.23^{b}	4.33 ± 0.31^{b}	5.25 ± 0.26^{a}	3.61 ± 0.23^{c}	4.43 ± 0.21^{b}	<0.001
(26) Lasting sense	4.34 ± 0.35^{b}	4.06 ± 0.39^{b}	4.25 ± 0.26^{b}	3.82 ± 0.28^{c}	3.83 ± 0.19^{c}	4.75 ± 0.23^{a}	0.001
(27) Soft-sweet sense	4.87 ± 0.32^{a}	4.06 ± 0.36^{b}	4.34 ± 0.37^{b}	4.02 ± 0.26^{b}	3.81 ± 0.24^{c}	5.26 ± 0.25^{a}	<0.001
(28) Fullness sense	4.68 ± 0.14^{a}	4.05 ± 0.34^{b}	4.26 ± 0.25^{a}	4.04 ± 0.23^{b}	4.11 ± 0.12^{b}	4.36 ± 0.31^{a}	0.400
(29) Coordinating sense	6.05 ± 0.38^{a}	4.63 ± 0.30^{b}	5.66 ± 0.43^{a}	4.41 ± 0.41^{b}	4.52 ± 0.23^{b}	6.08 ± 0.56^{a}	<0.001
(30) He-run sense	5.06 ± 0.37^{b}	4.05 ± 0.16^{c}	4.45 ± 0.41^{b}	4.03 ± 0.57^{c}	3.81 ± 0.24^{c}	6.68 ± 0.39^{a}	<0.001
(31) Whole style	6.84 ± 0.26^{a}	6.58 ± 0.57^{a}	6.81 ± 0.22^{a}	6.23 ± 0.29^{b}	6.04 ± 0.31^{b}	6.57 ± 0.24^{a}	0.300

Data are presented as the mean ± SD. $^{a-f}$Mean values of the same row in the six groups with unlike letters are significantly different ($P < 0.05$).

style typicality. Another example is the parameter jiao-xiang, which has a standard score range of 3.6–4.2. It was achieved by analyzing many samples. If a Chinese Baijiu sample has a score of jiao-xiang between 3.6 and 4.2, the sense feature score will be 3. When samples have a standard score 1 unit higher than 4.2 or 1 unit lower than 3.6, they will receive a sense feature score of 2.2 unit deviation, which leads to a sense feature score of 1 (Table 4).

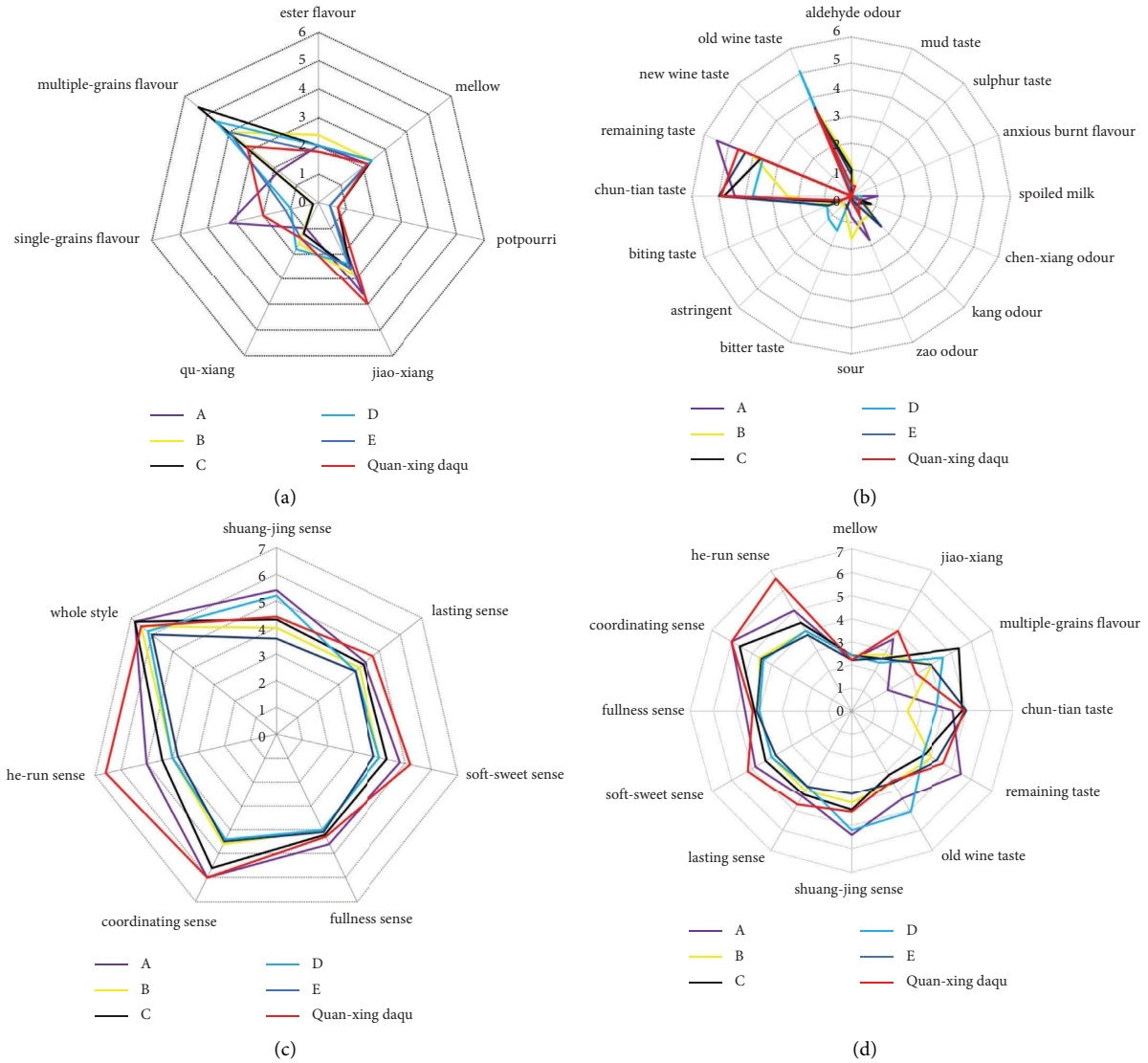

Figure 1: The flavor features of the 6 strong-aroma Baijiu. (a) Ester, mellow, potpourri, jiao-xiang (caramel), qu-xiang (starter), single-grain, and multiple-grains flavor; (b) aldehydes, mud, sulphur, anxious burnt, spoiled milk, chen-xiang (ageing), kang (rice husk), zao (jujube), sour, bitter, astringent, biting, chun-tian (ethanol and sweet), remaining, new wine, and old wine taste; (c) Shuang-jiang (clean), lasting, soft-sweet, fullness, coordinating, he-run (soft, moistening, and harmonious), whole style sense; (d) typical characteristics of the strong-aroma Baijiu: mellow, jiao-xiang (caramel), multiple-grains, chun-tian (ethanol and sweet), remaining, old wine, Shuang-jing (clean), lasting, soft-sweet, fullness, coordinating, he-run.

Table 3: Flag value range of sense style.

Sense features	Range of standard scores
Mellow	2.0–2.5
Chun-tian taste	4.7–5.2
Shuang-jiang sense	4.5–4.9
Fullness sense	4.5–5.0
Jiao-xiang	3.6–4.2
Remaining taste	4.3–4.7
Lasting sense	4.5–4.8
Coordinating sense	5.6–6.2
Multiple-grains flavor	3.1–3.7
Old wine taste	3.6–4.1
Soft-sweet sense	5.3–5.8
He-run sense	6.5–7.0

Table 4: The points table of the sense feature in the sample.

	Lower	Slightly low	Standard score	Little high	Higher
Score of jiao-xiang	−2.0	−1.0	3.6–4.2	+1.0	+2.0
Standard score	1	2	3	2	1

Table 5: Decision table of product' consistency.

	Lower	Slightly low	Standard score	Little high	Higher
Reserved portion	1	2	3	2	1
Mellow			√		
Jiao-xiang			√		
Multiple-grains flavor			√		
Chun-tian taste			√		
Remaining taste			√		
Old wine taste		√			
Shuang-jing taste		√			
Lasting sense			√		
Soft-sweet sense		√			
Fullness sense		√			
Coordinating sense			√		
He-run sense			√		
Total points			32		

This method was used to analyze the typical styles of Quan-xing daqu Baijiu, and the results are shown in Table 5. For the 12 enumerative indexes, the standard full score was 36. As the score of the sample was 32, its Cronbach alpha coefficient value was 32/36, which is equal to 88.9%. Based on the analysis and validation of 120 samples of Quan-xing daqu Baijiu, the typical standard of Quan-xing daqu Baijiu was established. When the Cronbach alpha value was higher than 81%, it indicated that the sample style was typical and stable. When the Cronbach alpha value was between 73% and 81%, it indicated that the sample had Quan-xing daqu's style, but the stability was bad. When the Cronbach alpha value was lower than 73%, it meant that the sample had changed and that the product was not typical of Quan-xing daqu Baijiu.

4. Conclusion

This study used GC-O to analyze the important aroma flavors of Quan-xing daqu Baijiu. First, scientific analysis was performed to determine the individual style of Quan-xing daqu Baijiu by establishing the flavor fingerprint of the strong flavor Baijiu. And then, extended the techniques of flavor fingerprinting to establish a judgment method of concordance rate for the style of Quan-xing daqu Baijiu.

According to the results of GC-O analysis, the main flavor compounds that formed typical styles were evaluated as 3-methylbutanol, ethyl butyrate, ethyl hexanoate, ethyl acetate, ethyl caprylate, caproic acid, acetic acid, phenethyl alcohol, 2-methylbutyric acid, 4-methyl valeric acid, and so on. Ethyl hexanoate mainly contributes to the strong aroma and ensures the strong flavor of the Baijiu style of Quan-xing daqu, together with other flavor compounds. Ethyl acetate contributes significantly to the flavor of Quan-xing daqu Baijiu and gives it a mild flavor. Coordinated with other flavors, it was the key factor in forming the elegant fragrance of Quan-xing daqu Baijiu. Acetal was one of the index components for spirit ripening and was the flavor component that brought the he-run (soft and moistening) feature. 2.3-butanedione (diacetyl) was the flavor component that presented the mellow feature.

Using the analysis techniques of flavor fingerprinting to analyze the style characteristics of Quan-xing daqu Baijiu from fragrance, taste, and entirety style, and the different sense features between Quan-xing daqu Baijiu and other strong-aroma Baijiu were clarified. Quan-xing daqu Baijiu was obviously different from the others in "two fragrances": potpourri and sesame flavor; and "four tastes": chun-tian taste, lasting sense, Shuang-jing sense, and coordinating sense. Using the analysis techniques of flavor fingerprinting, the evaluation method for the typical style concordance rate was established using the Cronbach alpha coefficient. 81% and 73% are the two standard values to evaluate if the sample is typical and stable, typical but not stable, or not typical.

Data Availability

Since this paper mainly studied the sensory flavor of Chinese Baijiu and assigned sensory values to it, the data are presented in the table of the paper.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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