Sensory descriptive analysis of green tea: correlation with chemical components

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Abstract. Quantitative descriptive analysis was used to determine the taste of 12 Sichuan green tea, and to analyze the correlation between the chemical components and taste attributes of tea infusions. The results showed that there is an interaction between the taste properties of tea, and the main taste attributes were bitterness and astringency, while the related components were catechin and tea polyphenols, and the effects of caffeine were still to be further investigated.

1. Introduction

Green tea is a kind of non-fermented tea, which is made of fresh tea by fixation at high temperature, kneading and drying. At the high temperature, polyphenoloxidase loses its activity, which makes green tea retain more ingredients in fresh tea leaves [1]. Taste, as one of the most important quality characteristics of tea, plays an important role in the quality identification of green tea. The taste of the green tea is mainly determined by the chemical components contained, such as the tea polyphenol with bitter taste and the astringency, the bitter taste of the caffeine, the umami taste and bitter taste of the amino acids, the sweet taste of the sugar and so on, and these non-volatile components are combined together to form the taste of the green tea [2]. In recent years, the taste substance analysis of green tea includes HPLC, different versions of GC, and various types of spectroscopy. However, the quantitative data provided by these devices do not interpret the overall taste, because these methods can detect the content of each taste substance separately, instead of revealing the interaction between taste substances, such as synergy and inhibition [2].

Sensory analysis can provide a comprehensive and direct measurement of the perceived intensity of target attributes, such as appearance, color, aroma, taste and texture, which often used for food quality control [3]. Tea quality is usually evaluated by professional tea tasters based on the appearance, aroma and taste of the tea brew, however, the concept of these terms is fuzzy and the quantitative scale is lacking, and the quality of the product can not be reflected objectively [4]. Quantitative description analysis can objectively characterize and identify the quality of products, and has. It can not only qualitatively analyze the samples, but also analyze the measured data by multivariate statistical method, so as to achieve the purpose of combining qualitative and quantitative analysis [5].

The purpose of this study is to evaluate the taste of green tea by means of quantitative description analysis, to establish the correlation between the ingredients of the main flavor and to provide methodological guidance for quality control and standardized production of the tea.
2. Experimental

2.1. Materials
Twelve samples of Sichuan green tea were selected as the research objects. The tea samples were provided by Sichuan National Tea Product quality Supervision and Inspection Center. Electrothermal constant temperature blast dryer (Shanghai Qixin Scientific Instrument Company Limited); BS-124S electronic analysis balance (Shanghai); UV-2550 UV-vis spectrophotometer.

2.2. Analysis of major constituents of the tea infusions
Tea polyphenol content: ferrous tartrate-colorimetric method; total amino acid total: trione-trione colorimetric method; soluble total sugar: ketone-sulfuric acid method; total amount of catechin: vanillin colorimetry; caffeine: ultraviolet spectrophotometry. All measurements were repeated three times and the mean value of the 3 results was taken.

2.3. Quantitative Descriptive Analysis
Eleven (9 female, 2 male) trained team members were recruited from the Department of Tea in the Sichuan Agricultural University to take part in the sensory evaluation, ranging from 19 to 25 years old without a history of taste disorder. At room temperature 20 ± 5°C, weighing 3.00g of green tea in a 150ml refined tea review cup, soaking in boiling water for 4 min, filtering, and cooling to room temperature. Tea was randomly coded in three digits and presented randomly to 11 evaluators. Quantitative sensory analysis was carried out by linear scale method to evaluate the bitter, astringent, fresh, sweet, concentrated, soft taste and sweet taste of tea soup. Each attribute was given five scales and its representative score: very weak (0-2), slightly (2-4), moderate (4-6), compared with (6-8), very (8-10). Team members need to gargle with a large amount of mineral water between sample tests, with 2 minutes of rest per sample and 10 minutes of rest per treatment room to minimize the impact of legacy and fatigue. Each sample

| Table 1. Definitions of sensory attributes for tea samples |
|-----------------------------------------------|
| Attribute          | Definition                                |
|-------------------|-------------------------------------------|
| Concentration     | The concentration of tea infusions        |
| After taste       | Taste turns from bitterness to sweetness  |
| Coordination      | Taste of coordination                     |
| Umami             | Intensity of umami taste                  |
| Sweetness         | Intensity of sweet taste                  |
| Bitterness        | Intensity of bitter taste                 |
| Astringency       | Intensity of astringent taste             |

retained 7 times 8 s in the mouth to dispel phlegm, and the taste and taste properties in Table 1 were evaluated repeatedly.

2.4. Data Analyses
Spearman’s linear correlation coefficient and linear regression were calculated by software of SPSS 10.0 for Windows (SPSS Inc. Chicago, Illinois, USA).

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4. Results and Discussion

4.1. Sensory Evaluation results of Green Tea Taste

The QDA sensory evaluation are shown in Table 2, the results show that the intensity of bitter and astringent taste of tea infusions is much higher than that of umami and sweet taste, the umami and sweet taste of tea infusions is difficult to be perceived, indicating that bitter and astringent taste is the main taste of green tea, umami and sweet taste is its supplementary taste. The results of correlation analysis between taste quantitative attributes (Table 3) showed that there is an interaction between the taste properties of tea. The concentration attribute was significantly negatively correlated with sweetness and bitterness and significantly positively correlated with sweetness and bitterness. There was a significant positive correlation between sweetness and umami. Among all the attributes, only taste of coordination was significantly correlated with other attributes (umami, sweet, bitter, astringent, concentration, and after taste), which was positively correlated with umami, sweetness, and after taste, and negatively correlated with bitterness, astringency, and concentration. However, there is no significant correlation between the umami and sweetness, astringency, bitterness,

Table 2. Means of four taste quality attributes

| No. | Umami  | Sweetness | Bitterness | Astringency | Concentration | Coordination | After taste |
|-----|--------|-----------|------------|-------------|---------------|-------------|------------|
| 1   | 1.2±0.41| 0.9±0.84  | 3.4±1.15   | 2.6±0.96    | 4.4±1.06      | 3.2±1.40    |
| 2   | 1.6±0.60| 1.1±0.72  | 3.1±1.05   | 2.8±0.97    | 4.1±0.69      | 3.5±1.16    |
| 3   | 1.1±0.82| 0.6±0.53  | 4.5±1.06   | 3.5±1.71    | 5.3±0.61      | 2.9±0.98    |
| 4   | 1.2±0.46| 0.9±0.60  | 4.0±0.88   | 2.5±1.54    | 4.7±0.91      | 3.3±1.49    |
| 5   | 1.4±0.66| 0.8±0.60  | 3.7±0.91   | 2.7±1.47    | 4.6±0.83      | 3.4±1.34    |
| 6   | 1.5±0.64| 0.7±0.60  | 4.2±0.61   | 2.5±1.37    | 4.9±0.90      | 3.1±1.11    |
| 7   | 1.5±0.53| 1.4±0.93  | 3.6±1.07   | 2.7±1.50    | 4.5±0.99      | 3.7±1.25    |
| 8   | 1.5±0.55| 1.4±0.72  | 3.5±0.73   | 2.5±1.02    | 3.9±0.78      | 3.8±1.50    |
| 9   | 1.1±0.60| 1.0±0.75  | 4.0±1.47   | 3.2±1.03    | 4.5±0.84      | 2.7±1.32    |
| 10  | 1.2±0.69| 0.9±0.66  | 4.0±0.89   | 3.3±1.34    | 4.4±0.85      | 3.2±1.20    |
| 11  | 1.5±0.71| 1.2±0.84  | 3.8±1.28   | 3.0±1.41    | 4.4±0.80      | 3.4±1.42    |
| 12  | 1.4±0.67| 1.3±0.84  | 3.3±1.13   | 2.4±1.37    | 4.2±0.69      | 3.8±1.27    |
Correlation between sensory attributes

| Attribute   | Umami | Sweetness | Bitterness | Astringency | Concentration | Coordination | Aftertaste |
|-------------|-------|-----------|------------|-------------|---------------|--------------|------------|
| Umami       | 1     |           |            |             |               |              |            |
| Sweetness   | 0.537 | 1         |            |             |               |              |            |
| Bitterness  | -0.562| -0.672**  | 1          |             |               |              |            |
| Astringency | -0.530| -0.319    | 0.559      | 1           |               |              |            |
| Concentration| -0.492| -0.789**  | 0.843**    | 0.426       | 1             |              |            |
| Coordination| 0.715**| 0.764**   | -0.707**   | -0.644**    | -0.655**      | 1            |            |
| Aftertaste  | 0.594**| 0.802**   | -0.403     | -0.618      | -0.514        | 0.677**      | 1          |

this may related to perception of umami in the tea infusions strength is too weak. In addition, bitterness and astringency are the two main attributes of the taste of green tea infusions, the correlation coefficient between them is higher, but did not achieve significant correlation. Therefore, QDA sensory analysis is of great significance in objective characterization of the taste of green tea infusions, not only because it can quantitatively analyze the taste intensity of tea infusions, but also because it can analyze the interaction between taste.

4.2. Correlation Analysis between Sensory results and Taste substance content

The correlation analysis (Table 4) between taste attribute and taste substance content of tea infusions showed that tea polyphenols, caffeine, water extract, soluble sugar, total catechin and total free amino acids were significantly correlated with different taste properties of tea infusions, respectively. The results were basically consistent with the previous studies on the correlation between the content of taste substances and taste quality in tea infusions. The contents of tea polyphenols, water extract, caffeine and catechin were positively correlated with bitterness, astringency and concentration, but negatively correlated with umami, sweetness, taste of coordination and the after taste, only the correlation coefficient was different. The total amount of free amino acids was positively correlated with umami, negatively correlated with bitterness and astringency, but none of the correlations were significant. There was a significant positive correlation between soluble sugar and sweetness and after taste, and the correlation coefficients were 0.600** and 0.678**, respectively, but there was no significant correlation with umami, bitterness, astringency, concentration, and coordination, among which the correlation with coordination was higher. Although previous studies have linked sensory
quality to chemical composition, little research has been done on the correlation between taste attributes and chemical composition in sensory quality.

5. Conclusions
In this paper, the sensory evaluation of green tea taste attributes was carried out with QDA sensory evaluation as the center, and the correlation between different kinds of green tea taste attributes and main taste components was analyzed. The results showed that the main taste of green tea was bitterness and astringency, and there was a significant correlation between different taste attributes, which indicated that people could sense the interaction between different taste in sensory evaluation. In the study of the correlation between taste attributes and chemical components, the total amount of catechin and tea polyphenols had significant effects on the bitterness and astringency of tea infusions, while caffeine had no significant correlation with astringency of tea infusions. Therefore, the effect of caffeine on the bitterness and astringency of tea infusions needs to be further studied. In addition, the total amount of taste chemical components is only determined, so it is necessary to further study the chemical components and explore the relationship between taste properties and chemical components.

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