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ORIGINAL ARTICLE

Effect of Optimizing Brewing Conditions on Improving the Quality of Ya'an Tibetan Tea Soup

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Abstract

This study investigated the effect of brewing conditions on the enhancement of Tibetan tea quality, focusing on the effects of water pH, tea dosage, and brewing temperature on the sensory profile of tea infusions. Utilizing the single-factor experimental design, the research revealed that water pH, tea dosage, and brewing temperature significantly influence the flavor characteristics of Tibetan tea. Principal component analysis identified two key components, accounting for a cumulative variance contribution of 86.157%. The comprehensive evaluation indicated that optimal brewing conditions for Tibetan tea were achieved with a water pH of 8.0, tea dosage of 4 g, and brewing temperature of 100°C, resulting in superior sensory quality of the tea infusion.

Keywords: **Tibetan tea, brewing conditions, sensory quality, quality constituents**

Introduction

1.1 Research Progress on Tea Brewing Conditions

Water is the mother of tea, and water is the main carrier for the release and formation of tea color and flavor. For different types of tea, the water quality suitable for brewing requirements is not the same, but an important part of the appropriate water is pH , a proper water pH can better release the color and flavor of tea.

For fermented teas, current research indicates that higher pH water results in superior tea quality. Few studies have suggested that water with a slightly higher pH is suitable for brewing fermented tea types [1]. Specifically, spring water with a pH of 7.4 has been shown to produce black and oolong teas of significantly better quality compared to lower pH mineral water and purified water. Similar conclusions were drawn by Cai [2], who found that black and dark teas brewed with Nongfu Spring water (pH 7.24±0.02) exhibited better quality than those brewed with Wahaha purified water and Baishuishan water, both of which have a pH of approximately 6. In black tea, different water qualities resulted in different tea characteristics; ultra-pure water and pure water with the lowest pH value had higher tea polyphenol content, ranging from 7.36% to 7.57%, whereas mineral water with the highest pH value had the lowest tea polyphenol content **Error! Reference source not found.**. The study revealed significant differences in pH, electrical conductivity, tea polyphenols, and L-value among teas brewed with different water qualities, indicating a sensitivity to water quality, with pH and electrical conductivity influencing the color stability of the tea infusion [4].

For non-fermented teas, it is advisable to use water that is neutral to acidic or slightly acidic for brewing. Green tea brewed with mountain spring water has better color, flavor, and consumer acceptance **Error! Reference source not found.**. Meanwhile, using slightly acidic purified water results in a higher extraction of tea soup components, such as tea polyphenols and amino acids, producing a light yellow-green infusion that exhibits a "fresh and mellow" taste quality, thus demonstrating better sensory characteristics. Therefore, a pH of weakly acidic and less mineral elements in pure water is suitable for brewing green tea[Error! Reference source not found.]. Gong et al.[Error! Reference source not found.] also confirmed that purified water with weakly acidic pH, low content of Ca^{2+}, Mg^{2+}, and total ions, and Tiger Spring were more suitable for brewing Longjing tea, and it was able to control the bitter, astringent, and freshness of tea soup in terms of flavor quality, as well as reflecting the richness and purity of the unique aroma of the tea broth. The water quality in the pH range from 6 to 7 can better present the apricot yellow or light apricot yellow color of White Tea[8].

Compared to Green Tea and Black Tea, there are relatively few studies on the brewing conditions of Dark Tea. The representative types of Dark Tea include Yunnan Pu-erh, Sichuan Tibetan tea, Hubei green brick, Hunan Poriao brick, and Guangxi Liu Bao tea; previous studies on the brewing of the above types of tea mainly focused on the ratio of tea to water, the temperature of the brewing water, the brewing time, and the number of brewing times[Error! Reference source not found. 13], while neglecting the study of water quality itself. Only one article found that after adding baking soda to the water to reach a pH of 8.0, the quality of brewed Yunnan Pu-erh tea was better than that of other pH gradients[14]. Research on the brewing conditions of Ya'an Tibetan tea in Sichuan Province is also scarce, and only one article was found on this aspect of the study. Gu[15] conducted a sensory evaluation to study the effects of three brands of bottled water—Bingchuanshidai mineral water, Gugubingchuan water, and Laoequan water—on the brewing of Ya'an Tibetan tea, and found that Laoequan water produced the best quality tea. However, this study only evaluated tea based on sensory analysis and did not address the extraction rates of quality components in the tea soup, failing to analyze the reasons for the differences in tea quality from a physicochemical perspective.

There is a variety of drinking water available on the market, but unsuitable drinking water may reduce consumer acceptance of tea. Therefore, it is essential to explore water that is appropriate for brewing Tibetan tea. By optimizing brewing conditions, we can provide consumers with guidance on their daily tea consumption, thereby better showcasing the inherent quality of Tibetan tea while enhancing consumer acceptance and satisfaction.

1.2 The Primary Acid Regulators in the Context of Food Applications

1.2.1 Citric Acid

Citric acid, an edible organic acid, is a widely used organic acid, which recognized as the "primary edible acidulant" in the food and beverage industry, as per GB2760—2014 and GB1886.235-2016 regulations[16]. At present, citric acid is the largest acidulant used in the food industry, accounting for over 70% of the market share. It plays an important role in antioxidant activity, pH regulation, inhibition of microbial growth, and color preservation in fruits and vegetables[17]. Additionally, it can enhance normal metabolism in the body, and an appropriate dose is harmless to the human body.

1.2.2 Baking Soda

Baking soda is a widely used food additive in the food industry (GB1886.2-2015) and is commonly incorporated in the production of carbonated drinks, beer, candy, and pastries. By 2022, the consumption share of the food additive sector reached 32%. As a strong base and weak acid salt, it is frequently employed to enhance acidity and modulate flavor profiles, which are applicable to dairy products, beverages, and other products that need to be controlled. Owing to the presence of milk proteins and specific components in coffee beverages, when the pH falls below 6, acidic substances in coffee can interact with proteins, leading to denaturation, coagulation, and precipitation. Therefore, the addition of baking soda to coffee drinks can be used to adjust the pH and maintain stability[18]. It also serves as a stabilizing agent in food products, helping to preserve their texture and extend their shelf life. For instance, sodium bicarbonate aids in maintaining product uniformity and preventing stratification in frozen beverages and jams. Moreover, adding baking soda to water can increase the water pH, improving the quality of Yunnan Pu-erh[14].

To explore the changes in sensory quality and quality components of Tibetan tea soup under different brewing conditions, and to clarify the effects of water pH, tea dosage, and brewing temperature on the quality of Tibetan tea soup, citric acid and baking soda were used to prepare drinking water with different pH levels to brew Tibetan tea.

2. Materials and Methods

2.1 Materials and Instrument

2.1.1 Materials and Reagents

Material: Tibetan Tea produced by Zhougongshan factory (Loose); Water (H_2O): Bingxue Gongquan Bottled Water (Ya'an Fuying Business Services Co., Ltd.)

Reagent (food grade): citric acid (Weifang Ensign Industrial Co., Ltd.), sodium bicarbonate (Jinan Baosho Food Technology Co., Ltd.)

Reagents (analytically pure): absolute ethanol, methanol, fulinphenol reagent, sodium carbonate, disodium hydrogen phosphate, ninhydrinone, sodium bicarbonate, saturated oxalic acid, hydrochloric acid, sulfuric acid, stannous chloride, etc.

2.1.2 Major Instruments

Evaluation cups and bowls, magnetic stirrer, Thunder Magnetic pH meter, water bath, oven, small colorimeter CR-10 PLUS, TDS water quality rapid detection pen, EOS-M200 camera, camera obscura.

2.2 Methods

2.2.1 Preparing drinking water with different pH levels

Citric acid and sodium bicarbonate were added according to the table below to prepare solutions of varying pH levels intended for brewing tea.

Table 1 Prepared with different pH water quality solutions

Solutions' name	Citric acid addition（mg/L）	Baking soda addition（mg/L）	Actual pH
Solution-A	15mg	/	4.05±0.03
Solution- B	1.5mg	/	5.04±0.01
Solution- C	Bingxue Gongquan bottled water		6.14±0.05
Solution- D	/	10mg	7.07±0.04
Solution- E	/	85mg	8.00±0.02

2.2.2 Experimental Design

2.2.2.1 Single Factor Experiments

To explore the effects of three factors (water pH, tea quantity, and brewing temperature) on the quality of Tibetan tea at five levels, the numerical range of the orthogonal test was obtained by considering the comprehensive score of the sensory evaluation as the investigation index. According to previous studies, most teas can be brewed for 5 min to obtain the highest antioxidant activity; therefore, a fixed brewing time of 5 min was used. The single-factor experiment is shown in the table below:

Table 2 Single Factor Trial Design Form

Factors / Levels	Water pH	Tea Amount (g)	Brewing Temperature（℃）
1	4	3	60
2	5	4	70
3	6	6	80
4	7	6	90
5	8	7	100

2.2.2.2 Orthogonal Design of Experiments

Based on the single-factor experiment, the water pH (A), tea dosage (B), and brewing temperature (℃) were used to conduct the $L9(3^4)$ orthogonal test, and the comprehensive score of the sensory evaluation of tea soup was used as the investigation index to determine the optimal brewing conditions of Ya'an Tibetan tea.

Table 3 Level table of orthogonal test factors

Factors / Levels	A-Water quality pH	B-Tea Amount (g)	C-Brewing temperature (°C)
1	6	4	80
2	7	5	90
3	8	6	100

2.2.3 Sensory Evaluation Methods

According to national standards, standard evaluation cups (250mL evaluation cups) were utilized. After brewing for five minutes at various pH levels (4, 5, 6, 7, and 8), different amounts (3, 4, 5, 6, and 7 g), and varying water temperatures (60, 70, 80, 90, and 100℃), the tea infusion was poured into evaluation cups. The color, aroma, and taste of the teas were assessed. Sensory evaluations of the color, aroma, and taste are conducted in accordance with the "Terminology of Sensory Evaluation of Tea."

Table 4 Quality comments and quality factor scores of dark tea

Factor	Level	Quality Characteristic	Rating Range	Evaluation Coefficient
Color	first	Intense, orange-red, bright	90~99	30%
	second	The red is thick, orange-red, and still bright	80~89	
	third	Deep red or dark yellow that is somewhat dull or turbid	70~79	
Aroma	first	Pure and lasting, free from off-odors, with a high and refreshing aroma	90~99	20%
	second	The fragrance is noble and pure, devoid of any off-odors	80~89	
	third	Still pure	70~79	
Taste	first	Rich and with a sweet, refreshing aftertaste	90~99	50%
	second	Relatively rich	80~89	
	third	Still rich, with a slight bitterness	70~79	

2.2.4 Detection of physical and chemical components of tea soup

2.2.4.1 Tea Soup Quality

1）pH Value：Determined by the pH meter

2）Total dissolved solids (TDS) and Electrical Conductivity (EC)：Refer to GB/T5750.4—2006；

3) Lab Color Values of Tea Soup

The Adobe Color CC extract Lab color values were used according to the method described by Ma [19]. First, the tea infusion was cooled to room temperature, which required approximately 30 min, and then the picture was taken in the camera obscura. After that, uploading the tea soup images and moving the cursor to the tea soup area to read the color parameter values of three adjacent points, which were then averaged.

The URL：https://color.adobe.com/zh/create/image-gradient

2.2.4.2 Analysis of biochemical components of tea decoction

Cooling the tea soup that was brewed in 2.2.2.1 and 2.2.2.2, then filtering them for the determination of biochemical components.

The tea polyphenols were determined using the

GB/T8313-2008 method.

The amino acids were measured using the GB/T8314-2013 method.

Caffeine was assessed using the GB/T8312-2013 method;

Tea polysaccharides were quantified using the anthrone colorimetric method.

The Theabrownine was analyzed using the anhydrous ethanol precipitation method [20].

2.2.5 Statistical Analysis

All experiments were conducted in triplicate, and the experimental data were analyzed using Excel and SPSS version 27, with graphical representations created using Origin.

3.Results and Discussion

3.1 Effect of different water pH on the quality of Tibetan tea soup

3.1.1 The effect of water quality of tea soup under different water pH

The effects of water pH on the quality of Tibetan tea soup are shown in Table 5.

Table 5 Effect of different pH water quality on Tibetan tea soup

Factors	Levels	After brewing Tea soup pH	Scores			Sensory evaluation score
			Color	Aroma	Taste	
Water pH	4	5.00	77.28	83.23	70.05	74.86
	5	5.04	83.62	83.45	75.26	79.41
	6	5.11	87.16	86.31	82.41	84.62
	7	5.16	91.44	89.17	90.6	90.57
	8	6.04	94.32	90.56	94.38	93.60

As shown in Table 5, the quality of the tea infusions varied significantly at different water pH levels. There was a positive correlation between the water pH and sensory evaluation. As the pH of the water increased, both the pH of the brewed tea and its sensory score also increased. While numerous studies have shown that lower pH water is more suitable for brewing tea, some studies suggest that slightly higher pH water is better for brewing fermented teas[20]. For instance, spring water with a pH of 7.4 has been shown to produce superior quality in black and oolong teas compared to lower pH mineral and purified waters. Similar conclusions were drawn by Cai[21], who found that black tea brewed with natural spring water at a pH of 7.24 outperformed that brewed with Wahaha purified water and Baishui Mountain natural mineral water, both at pH 6. As the pH of the water increased, the color of the tea infusion deepened; tea brewed at pH 4.0 exhibits an orange-red hue, while tea brewed at pH 8.0 appears to be rich red. There were no significant changes in aroma; however, higher pH levels enhanced the flavor of tea, notably reducing its bitterness.

3.1.2 Color Differences Of Brewed Tea Under Different Ph Conditions.

Fig 1 illustrates that the pH of the brewing water significantly influences the color of the tea infusions. Notably, the color differences among the infusions at pH levels of 4, 5, and 6 were not significant, with the a* values remaining consistent across all the five pH gradients. In contrast, the tea brewed at pH 7 exhibited higher L* and b* values than those brewed at the other gradients, whereas the infusions brewed at pH 8 showed the lowest L* and b* values. Consequently, the tea brewed at pH 7 had the lightest color, whereas the infusion brewed at pH 8 was the darkest.

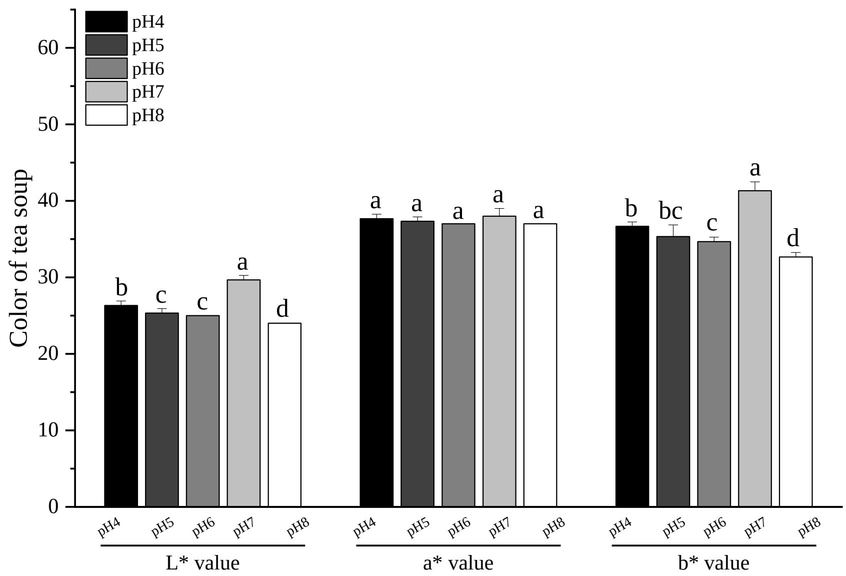

Figure 1 Color differences of brewed tea under different pH conditions

3.1.3 The quality components differences of tea soup under different pH water brewing

Figure 2 shows that the concentration of the extract in the tea soup brewed at different pH levels of the water showed significant differences.

1) The extraction concentrations of tea polyphenols in tea infusions brewed at different pH levels were ranked as follows: pH 5 > pH 4 > pH 8 > pH 6 > pH 7. The lowest extraction rate was 2.65%, which occurred in water with pH 7.Consistent with previous literature[22], acidic conditions were more conducive to the extraction of polyphenolic compounds.

2) Different pH levels of water significantly affected the extraction concentration of amino acids in tea infusions. There were notable differences in the amino acid concentrations between acidic and alkaline water conditions, with the extraction concentration ranking as follows: pH 4 > pH 5 > pH 6 > pH 8 > pH 7. Acidic conditions are conducive to amino acid extraction.

3) The extraction concentration of caffeine in tea infusions varied with different pH levels of water, showing a decrease in caffeine content as the pH of the water increased. The ranking of caffeine extraction concentrations was pH 4 > pH 5 > pH 6 > pH 8 > pH 7, with more caffeine extracted under acidic conditions, reflecting a trend similar to that of amino acid extraction.

4) In comparison, the tea polysaccharide content in tea soup brewed with different water qualities was relatively low, with the ranking of extraction concentrations as follows: pH 8 > pH 4 > pH 7 > pH 5 > pH 6. The extraction rates of the tea polysaccharides in both acidic and alkaline water were higher than those in the unadjusted water. The highest extraction rate occurred at pH 8.0, indicating that the addition of appropriate acids and bases benefits the extraction of tea polysaccharides.

5) There was no significant change trend with an increase or decrease in the pH of the brewing water. The extraction concentrations of theabrownin brewed at different pH values were ranked as follows: pH 8 > pH 5> pH 6> pH 4 > pH 7. The extraction rate of theabrownin was the highest at pH 8.0.

In summary, combining the sensory evaluation and extraction rates of quality components revealed that the higher the water pH, the better the tea soup quality. When the water pH was 8.0, the tea infusion exhibited a lower bitterness than the other pH levels. This is associated with a reduced content of bitter phenolic compounds and caffeine, whereas the functional components, tea polysaccharides, and theaflavins are present at higher concentrations.

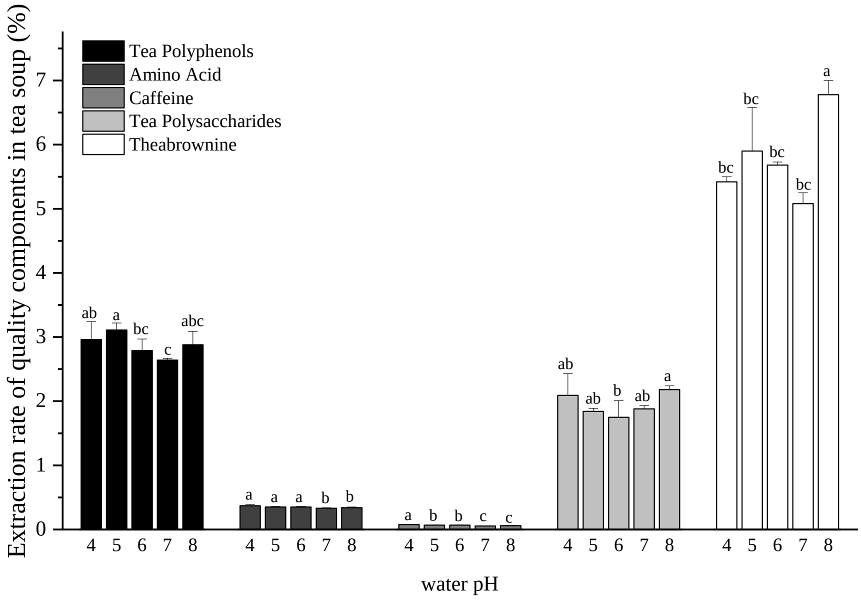

Figure 2 The quality components differences of tea soup under different pH water brewing

3.2 Effect of different tea dosage on the quality of Tibetan tea soup

Different tea dosages led to different sensory evaluations, and the specific data are presented in Table 6.

Table 6 Effect of different tea dosage on Tibetan tea soup

Factors	Levels	After brewing Tea soup pH	Scores			Sensory evaluation score
			Color	Aroma	Taste	
Tea dosage	3g	5.09	71.25	83.05	71.39	73.68
	4g	5.10	82.11	89.17	92.11	88.52
	5g	5.11	91.58	92.33	94.63	93.26
	6g	5.05	93.24	88.61	91.92	91.65
	7g	5.07	90.07	82.73	83.77	85.45

When the amount of tea was 3g~ 5 g, there was a positive correlation between the amount of tea consumed and sensory evaluation; when the amount of tea was more than 5 g, there was a negative correlation between the amount of tea consumed and sensory evaluation. With an increase in the amount of tea, the color of the tea broth gradually deepened, and when the amount of tea was 6 g or more, the color of the broth darkened significantly.

From Fig 3, it can be seen that the color of tea soup varies greatly with different tea quantities; with the increase in tea quantity, the L value and b value decreased significantly, in the range of 3–6 g. Although the difference in the value of tea broth was not significant, for the tea quantity of 7 g, the value of a was the lowest; therefore, with the increase in tea quantity, the brightness of the tea broth became darker and deeper in color.

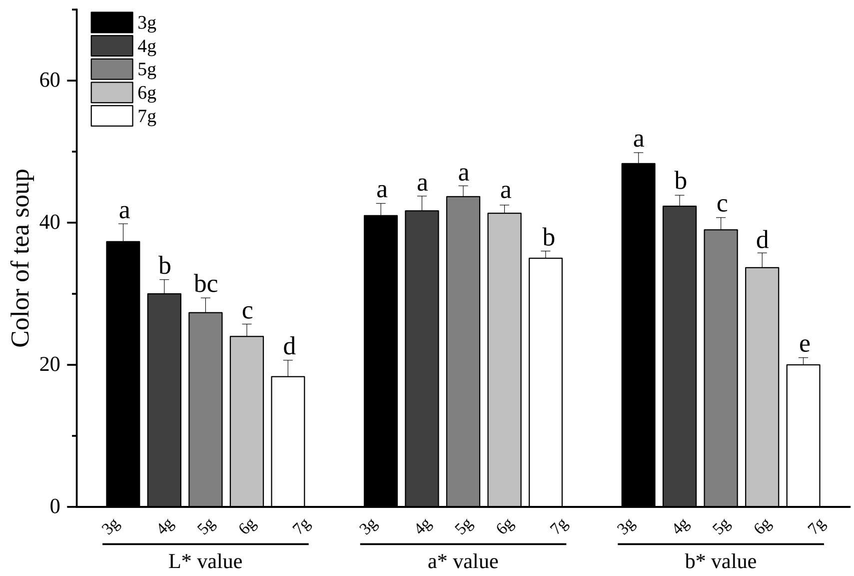

Figure 3 Differences in the color parameters of tea soup under different tea dosages

3.3 Effect of different brewing temperature on the quality of Tibetan tea soup

The effects of different brewing temperatures on the quality of tea soup are shown in Table 7.

Table 7 The effect of different brewing temperatures on Tibetan tea soup

Factors	Levels	After brewing Tea soup pH	Scores			Sensory evaluation score
			Color	Aroma	Taste	
Brewing temperture	60℃	5.23	75.67	79.51	86.21	81.71
	70℃	5.17	79.92	87.42	92.33	87.63
	80℃	5.13	82.16	85.73	84.72	84.15
	90℃	5.13	92.44	91.06	94.01	92.95
	100℃	5.09	94.67	90.15	89.22	91.04

The quality of Tibetan tea soup under different brewing temperatures varied greatly. Generally, the higher the temperature, the more favorable the leaching of the quality components. Yingde Black Tea brewed at 95℃ will produce sweet aroma and more aroma-active compounds[23]; in Zhang's paper[24], he noted that water temperature water temperatures above 80℃ are more conducive to the formation of aroma of Longjing tea; in oolong tea, the aroma is more intense with the increase in the temperature of the water, and the high-boiling-point in tea aroma substances are more easily volatilized at high temperatures, so it is recommended to brew Oolong tea with water above 98℃[25]. However, this does not mean that the higher the extraction rate, the higher the sensory score of the tea soup. In this experiment, the tea soup brewed at 90℃ was slightly better than that at 100℃, with the highest sensory score; and the sensory review of the tea soup brewed at 70℃ was better than that at 80℃, which may be due to the fact that the bitter and astringent caffeine substances can only be effectively leached out at 80℃ or above, so the tea soup brewed at 70℃ had a lower bitter and astringent flavors.

Fig 4 illustrates that the color differences in tea infusions are highly significant at different brewing temperatures. As the brewing temperature increased, both the L and b values showed a marked decrease, while the a value of the tea soup increased significantly. Therefore, as the brewing temperature rises, the brightness of the tea infusion becomes progressively darker, yet the color intensity deepens.

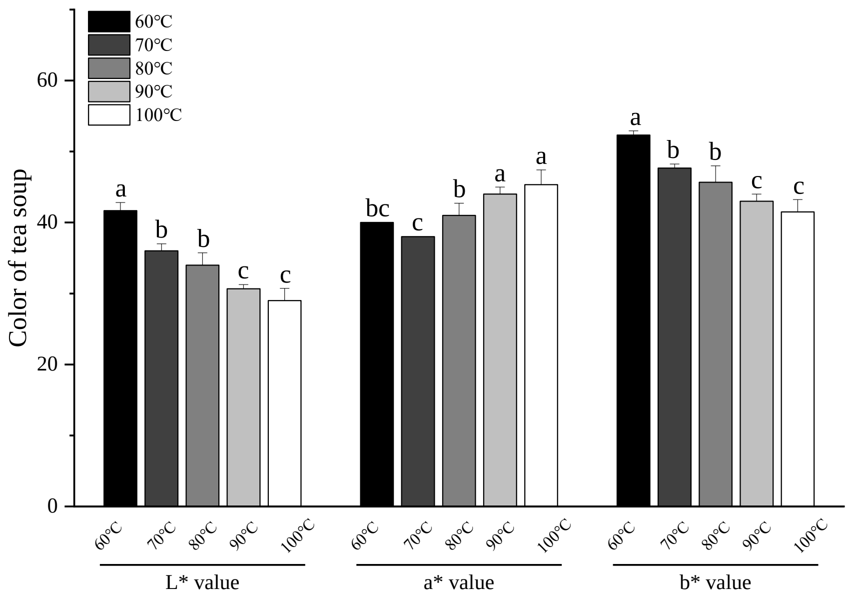

Figure 4 Difference in Tea Soup Color under Different Brewing Temperatures

Based on the single-factor test, a three-factor, three-level orthogonal test was conducted to analyze the sensory evaluation and content of the main physicochemical components of the tea broth produced under different brewing conditions.

3.4 Orthogonal experimental results

3.4.1 Sensory evaluation results

The results of sensory evaluation of the orthogonal tests are presented in Table 8.

Table 8 Orthogonal Experimental Sensory Score Scale

Group	Factors			Sensory evaluation score	EC	TDS
	A-Water quality pH	B-Tea dosage（g）	C-Brewing temperature（°C）			
1	A1	B1	C1	81.38	517.33	258.67
2	A1	B2	C2	79.62	736.00	368.00
3	A1	B3	C3	79.12	936.00	468.00
4	A2	B1	C2	88.09	604.00	301.67
5	A2	B2	C3	87.12	806.00	403.00
6	A2	B3	C1	89.37	872.00	436.00
7	A3	B1	C3	91.65	691.00	345.00
8	A3	B2	C1	90.11	755.00	377.00
9	A3	B3	C2	87.27	1003.33	501.33
K1	240.12	261.12	260.86			
K2	264.58	256.85	254.98			
K3	269.03	255.76	257.89			
k1	80.04	87.04	86.95			
k2	88.19	85.62	84.99			
k3	89.68	85.25	85.96			
R	9.64	1.79	1.96			

Table 8 shows that under different brewing conditions, the flavor of the tea soup in each treatment group was different. Group 7 (water pH 8.0, tea dosage 4 g, brewing temperature 100℃) had the highest sensory score. Through range analysis, the ranking of the sensory scoring factors was water pH> brewing temperature > tea dosage.

3.2.2 Orthogonal test physicochemical determination results

The effect of the quality components differences of tea soup under different brewing conditions

Table 9 Differences in tea composition under different brewing conditions

Group	Tea Polyphenols (%)	Amino Acids (%)	Caffeine (%)	Tea Polysaccharides (%)	Theabrownin (%)	pH	Sensory evaluation score
1	4.00	0.46	0.43	1.40	13.80	4.94	81.38
2	5.33	0.47	0.55	1.78	20.45	4.95	79.62
3	5.50	0.48	0.52	1.93	21.84	4.95	79.12
4	5.03	0.51	0.56	1.75	18.21	4.98	88.09
5	5.78	0.51	0.57	1.98	22.05	4.94	87.12
6	4.52	0.44	0.46	1.60	16.32	5.02	89.37
7	5.77	0.53	0.60	2.00	22.16	5.99	91.65
8	4.54	0.42	0.47	1.58	16.90	5.83	90.11
9	5.80	0.49	0.53	2.13	22.53	5.46	87.27

Table 9 shows that there were notable differences in the composition of tea infusions across the nine groups.The fundamental reason for the varying flavor profiles of the tea infusions lies in the different types and proportions of soluble compounds released under distinct brewing conditions. The pH content of amino acids, caffeine, tea polysaccharides, and tea soup was the highest in Group 7, and the content of tea polyphenols and theabrownin was slightly lower than that in Group 9, but the content was also higher, and the sensory performance was also the best. The lowest levels were observed in the first group.

3.2.2.1 Principal Component Analysis

Considering the varying degrees of influence that multiple factors and levels exert on various quality indicators of tea infusions, SPSS 27.0 software was utilized for dimensionality reduction. Principal Component Analysis was employed to extract the principal components that represented the original results, along with their contribution rates, as detailed in Table 10.

Table 10 Eigenvalues, variance contribution rate and cumulative contribution rate of components

Rank	Initial eigenvalues		
	Total	Variance Percentage	Cumulative percentage
1 tea polyphenol	4.428	63.253	63.253
2. Theabrownin	1.603	22.905	86.157
3. Tea polysaccharides	0.576	8.223	94.380
4. Caffeine	0.261	3.726	98.106
5 amino acids	0.125	1.788	99.895
6. Sensory scores	0.006	0.091	99.986
7. Tea soup pH	0.001	0.014	100.00

As shown in Table 10, two main components, tea polyphenol and theabrownin, were selected as the main components with eigenvalues greater than 1, and their variance contribution rates were 63.253% and 22.904%, respectively. The cumulative contribution rate was 86.157%, indicating that the two extracted principal components contained most of the information of the original variables. The composite scores of the two principal components were calculated according to formula (1) and sorted according to the composite scores; the results are shown in Table 11.

Formula（1）：Comprehensive score

$$=\sum_{i}^{2}\text{（Principal Component i Factor Score）}\times\frac{\text{variance contribution rate of principal component}}{\text{cumulative variance contribution rate of 2 principal components}}$$

Table 11 Comprehensive evaluation of tea soup under different brewing conditions

Group	Factor 1 Score	Factor 2 Score	Principal Component 1 Score	Principal Component 2 Score	Composite Score	Ranking
1	-1.52	-0.81	-1.09	-0.23	-1.32	9
2	0.29	-1.11	0.21	-0.31	-0.10	6
3	0.54	-1.22	0.39	-0.34	0.04	5
4	0.15	-0.07	0.11	-0.02	0.09	4
5	0.95	-0.32	0.68	-0.09	0.59	3
6	-1.08	0.22	-0.78	0.06	-0.71	8
7	1.05	1.56	0.75	0.44	1.19	1
8	-1.20	1.38	-0.86	0.39	-0.48	7
9	0.83	0.37	0.59	0.11	0.70	2
9	0.83	0.37	0.59	0.11	0.70	2

As shown in Table 11, the overall ranking of the different groups is as follows: Groups 7, 9, 5, 4, 3, 2, 8, 6, and 1.Groups 7 and 9 had better overall quality, and Group 1 ranked last. Through comprehensive analysis of the physical and chemical components and sensory evaluation, the tea soup brewed using the method of Group 7 was determined to be the best.

Conclusions

In summary, proper brewing conditions can improve the flavor quality of Tibetan tea. In this study, the single-factor test was used to explore the effects of water pH, tea dosage, and brewing temperature on the flavor of tea soup and the appropriate parameter range for each influencing factor was determined. Then, an orthogonal test was designed to evaluate the sensory evaluation of the tea soup prepared under different brewing conditions, and the main physical and chemical components such as tea polyphenols, free amino acids, and caffeine were determined. Principal component analysis was used to simplify the seven indices into two principal components, and the optimal brewing conditions of the Ya'an Tibetan brewing were comprehensively evaluated.

The results of the sensory evaluation indicated that the influence of the three factors on the sensory scores ranked as follows: water pH > brewing temperature > tea dosage. The optimized brewing conditions for Ya'an Tibetan tea were pH 8.0, tea a dosage of 4 g, and a brewing temperature of 100°C for 5 min. Under these conditions, the resulting tea infusion exhibited good sensory qualities and was rich in soluble compounds.

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