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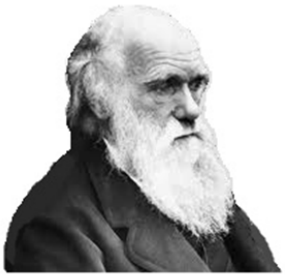

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Optimization the Preparation Process of the Compounded Tea of *Cyclocarya paliurus* and *Moringa* Leaves

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ABSTRACT

In this work, the preparation process of the compounded tea based on *Cyclocarya paliurus*, *Moringa* leaves and lotus leaves was optimized by adopting a mixture design and using the total triterpenes, flavonoids, and polysaccharides as evaluation indicators, together with the sensory evaluation. The results showed that the optimized ratio of *Cyclocarya paliurus, Moringa* leaves and lotus leaves is 1.5:0.3:0.2 (W:W:W).

***Keywords*:** *Cyclocarya paliurus*, Moringa leaves, Lotus leaves; compounded tea, optimized preparation process

1. INTRODUCTION

Cyclocarya paliurus (Bata1) ljinskaja (Chinese name is Qingqian Liu) is a dicotyledonous plant belonging to the Juglandaceae family, commonly known as *Cyclocarya*, sweet tea tree, and money tree. This unique species is native to China and its leaves are widely utilized for tea and functional foods [1-3]. Qingqian Liu contains a variety of active compounds such as triterpenes, polysaccharides, saponins, flavonoids, alkaloids, and amino acids [4]. It posses a wide spectrum of biological activities: such as lowering blood pressure, reducing blood lipids, antioxidant properties, anti-aging effects, anti-tumor, immune enhancement, and

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metabolism promotion [5-7]. The water extract of *Cyclocarya paliurus* is sweet in taste, and it was often called as "sweet tea" [8]. *Moringa* (*Moringa oleifera* Lam.) is a perennial tropical deciduous tree and belongs to the Moringaceae family and Moringa Adans genus. It serves as a novel green food resource and a traditional medicinal plant with significant economic and medicinal properties [9]. Moringa leaves are abundant in various nutritional and health-promoting components: such as vitamins, carotenoids, minerals, proteins, alkaloids, polyphenols, flavonoids, glycosides, and organic acid [10, 11], and it exhibits a wide spectrum of biological activities: including anti-tumor, anti-viral, antioxidant, anti-bacterial, anti-inflammatory properties, along with the ability to regulate blood sugar, blood lipids, and liver protection [12]. Lotus leaf, derived from Nelumbo nucifera Gaertn., a perennial aquatic herbaceous plant, is also known as lotus stem and lotus stem leaf. It contains many kinds of bioactive compounds such as alkaloids, flavonoids, saponins, steroids, polysaccharides, and volatile oils [13]. It has been demonstrated that Lotus leaf exhibited antioxidant, anti-aging, lipid-lowering, weight loss, anti-viral, anti-inflammatory, and antibacterial properties, as well as summer-heat polydipsia, summer-dampness diarrhea, and spleen deficiency diarrhea [14-16].

In this study, we opimized the preparation process of a compounded tea based on Qingqian Liu, Moringa leaves, and lotus leaves by sensory evaluation and component analysis, and the optimized ratio of *Cyclocarya paliurus*, *Moringa* leaves and lotus leaves is 1.5:0.3:0.2 (W:W:W).

2. MATERIALS

Cyclocarya paliurus was sourced from Xiamen Tasman Bio-Tech Research Institute, the Moringa leaves and lotus leaves used were commercially available. The phenol, sulfuric acid, methanol, and other reagents were analytically pure grade and were bought from Nanjing Chemical Reagent Co., Ltd.

3. EXPERIMENTAL PROCESSES AND METHODS

3. 1. Preparation of *Cyclocarya paliurus*, *Moringa* Leaves and Lotus Leaf Compounded Tea

The *Cyclocarya paliurus*, moringa leaves, and lotus leaves was crushed separately and sieved through a 60-mesh sieve to obtain three raw material powder. Then, we mixed three powdered materials in specific mass ratios to obtain the compounded tea.

3. 2. Basic component analysis

Moisture content was determined following the first method outlined in GB5009.3-2016, the "National Food Safety Standard for Determination of Moisture in Foods". Total ash content was determined using the first method of GB5009.4-2016, the "National Food Safety Standard for Determination of Ash in Foods". Total flavonoids were determined using the aluminum trichloride colorimetric method. Total polysaccharides were determined using the phenol sulfuric acid method with glucose as the standard. Total triterpenes were determined using the vanillin-Glacial acetic acid colorimetric method with ursolic acid as the standard.

3. 3. Data analysis

SPSS17.0 software was used for data statistics and analysis.

4. RESLUTS AND DISCUSSION

4. 1. Experimental formula design

In order to optimize the compounded tea formula, we conducted the L9(33) orthogonal experiment and the details were listed in **Table 1**. The prepared compound tea bags were soaked in boiling water twice and each one for 5 minutes, maintaining a tea-to-water ratio of 1:75 (W:V). The tea soup obtained from the two soakings was combined, filtered, and it was adjusted to a final volume of 200 mL for below use [17].

Table 1. Factors and levels of the 3-factor quality level orthogonal experiment of *Cyclocarya paliurus* and Moringa Leaves tea

Serial number	A (*Cyclocarya paliurus*)	B (Moringa leaves)	C (lotus leaf)
1	2.5	0.1	0.0
2	2.0	0.2	0.1
3	1.5	0.3	0.2

4. 2. Assessment method

In this study, sensory evaluation was conducted for evaluation the quality of different formula samples by 20 experients. The evaluation standards for the compounded tea were listed in **Table 2**.

Fuzzy comprehensive evaluation was then employed for analysis, utilizing the principle of maximum membership to determine the comprehensive evaluation grade for each formula. This process helped in screening and identifying the optimal formula [18-19].

In accordance with the Tea Sensory Evaluation Standard (GB/T23776-2018), the evaluation of the quality of the compounded tea involves 5 factors: aroma, color, taste, leaf shape, and leaf bottom, with weights of 20%, 30%, 30%, 10%, and 10%, respectively. However, to simplify the evaluation, the weights of the factors were adjusted to three categories: 25%, 30%, and 45%. Sensory evaluation was conducted at four levels: excellent (90), good (80), medium (70), and bad (60).

The evaluation factors are represented as U = (U1, U2, U3) for soup color, aroma, and taste, and the comments as X = (X1, X2, X3, X4) for excellent, good, medium, and bad. The weight set A = (A1, A2, A3, A4) corresponds to soup color, aroma, and taste with values (0.25, 0.30, 0.45), totaling 1. The comprehensive evaluation is calculated by multiplying each vector by its score and summing. The sample's comprehensive membership degree Y to each factor is obtained through matrix multiplication $Y = X \cdot R$, leading to the final comprehensive score of each product.

Table 2. Sensory evaluation criteria of *Cyclocarya paliurus* and *Moringa* Leaves tea

grade	Soup color	Aroma	Taste
excellent	Yellow-orange, translucent	Harmonious and pure aroma	Mellow and refreshing, with obvious sweetness and good taste
good	Yellow-orange, still translucent	More coordinated, accepting, peaceful	Mellow and refreshing, slightly sweet after taste
middle	Yellow-orange, light bright	Slightly aromatic	Mild, average taste
Difference	Yellow-orange, turbid, abnormal	The aroma is not obvious	Mild, bad taste

4. 3. Sensory evaluation of *Cyclocarya paliurus* Moringa tea

The tea soup obtained from soaking the compounded tea (which was prepared according to the proportions outlined in **Table 1**) was assessed based on the evaluation criteria specified in **Table 2**. The results are presented in **Tables 3** and **4**.

Table 3. Sensory evaluation results of *Cyclocarya paliurus* and *Moringa* Leaves tea

Recipe number	Formula			Soup color				Aroma				Taste			
	A	B	C	Excellent	Good	Medium	Bad	Excellent	Good	Medium	Bad	Excellent	Good	Medium	Bad
①	1	1	1	3	10	2	5	5	7	4	4	5	10	4	2
②	1	2	2	12	5	2	0	12	7	1	0	8	6	5	0
③	1	3	3	5	8	4	3	5	10	4	1	5	6	9	0
④	2	1	2	12	5	3	0	10	6	4	0	9	10	1	0
⑤	2	2	3	6	7	7	0	5	6	6	3	5	3	8	4
⑥	2	3	1	5	6	8	1	6	5	8	0	3	2	10	5
⑦	3	1	3	7	7	5	1	5	12	3	0	3	4	8	5
⑧	3	2	1	6	8	3	5	2	9	4	5	3	7	7	3
⑨	3	3	2	11	4	4	1	9	8	3	0	12	7	1	0
Weights				0.25				0.30				0.45			

Table 4. Comprehensive evaluation results of *Cyclocarya paliurus* and *Moringa* Leaves tea

Recipe number	Level 4 comprehensive evaluation score	Grade
①	X1={0.2250，0.4325，0.1750，0.1675}	Good
②	X2={0.5100，0.3025，0.1525，0.0000}	Excellent
③	X3={0.2500，0.3850，0.3125，0.0525}	Good
④	X4={0.5025，0.3775，0.1200，0.0000}	Excellent
⑤	X5={0.2625，0.2450，0.3575，0.1350}	Medium
⑥	X6={0.2200，0.1950，0.4450，0.1250}	Medium
⑦	X7={0.2300，0.3575，0.2875，0.1250}	Good
⑧	X8={0.2300，0.3575，0.2875，0.1250}	Good
⑨	X9={0.5425，0.3275，0.1175，0.0125}	Excellent

Table 4 illustrates that out of the 9 types of formulas, 3 received an “excellent” grade in the comprehensive evaluation, representing 33.3% of the total formulas; 4 were rated as “good”, making up 44.44% of the total formulas; and 2 fell under the “medium” grade, accounting for 22.22% of the total recipes. None of the formulas were classified as “bad”. Considering “excellent” and “good” as acceptable levels, it can be inferred that 77.77% of the compounded tea made from *Cyclocarya paliurus*, Moringa leaves, and lotus leaves is acceptable.

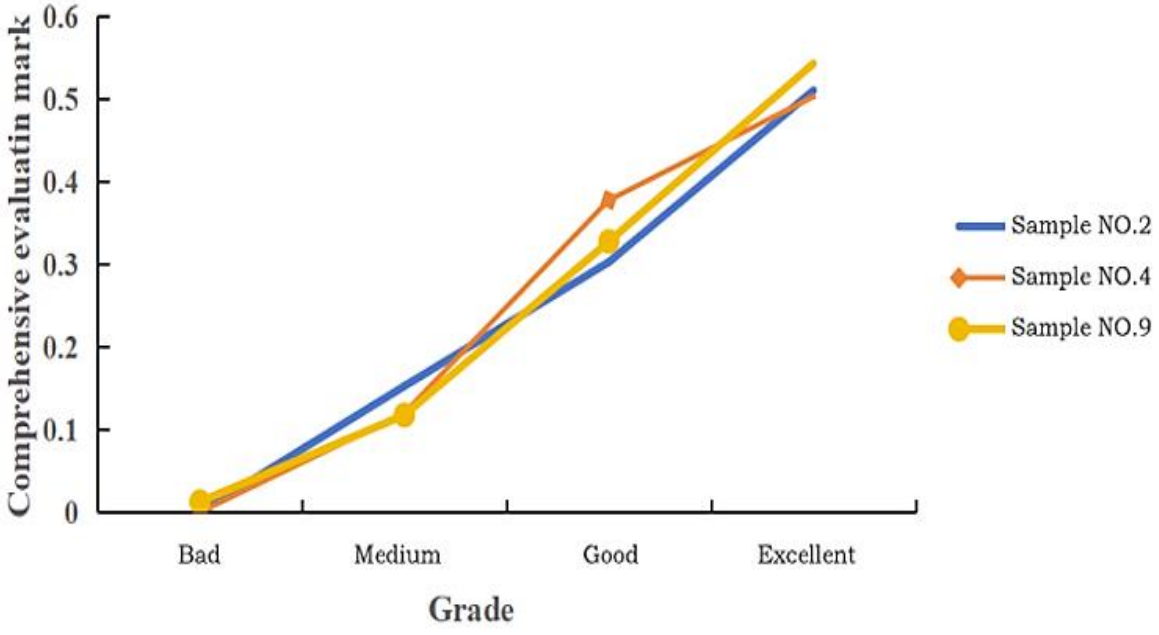

Figure 1. Fuzzy relationship curve

Fuzzy relationship curve analysis was conducted to determine the best formulas with "excellent" comprehensive evaluation results. The score distribution of participants for Formula No. 2, Formula No. 4, and Formula No. 9 was analyzed using fuzzy relationship curves. The fuzzy curve (**Figure 1**) revealed that the peak value of the three formulas was Y9 > Y2 > Y4. Among the superior grades, Formula 9 received the highest comprehensive evaluation score, followed by Formula 2 and Formula 4. Formula 9 showed a relatively concentrated proportion distribution of "excellent", "good", "medium", and "bad" grades, indicating a unified sensory evaluation by participants. The sensory quality of Formula No. 9 was superior to Formula No. 2 and Formula No. 4.

4. 4. Nutritional composition measurement results of the best formula

The study measured the active ingredient content in tea soup prepared with the optimal formula 9, using flavonoids, triterpenes, and polysaccharides as key indicators of product quality (refer to Table 5 for details). Results indicated that the total flavonoid content was 9.73 mg/g in pure *Cyclocarya paliurus* tea tea soup and 9.95 mg/g in formula 9 tea soup; polysaccharide content was 2.52 mg/g in pure *Cyclocarya paliurus* tea soup and 2.54 mg/g in formula 9 tea soup; triterpene content was 0.89 mg/g in pure *Cyclocarya paliurus* tea soup and 0.90 mg/g in formula 9 tea soup. Analysis from Table 5 revealed an increase in total flavonoid content in formula 9 tea soup compared to pure *Cyclocarya paliurus*, indicating that the compounded tea formula offers superior sensory quality and enhanced nutritional benefits, thereby maximizing its health-promoting effects.

Table 5. Content of major constituents of Cymbopogon flexuosus tea

Name	Moisture	Ash content	Leachate	Total flavonoids	Total triterpenes	Total polysaccharides
Cyclocarya paliurus (Batal.) Il jinsk.	7.81±0.03	9.73±0.31	25.34±0.12	0.74±0.24	0.89±0.04	2.52±0.02
Compounded tea	7.52±0.04	5.95±0.44	25.42±0.13	0.75±0.33	0.90±0.03	2.54±0.03

5. CONCLUSIONS

(1) The study optimized the formula of Qingqian Liu, Moringa leaves, and lotus leaf compound tea using a 3-factor, 3-level orthogonal experimental design. The ratio of Qingqian Liu to Moringa leaves to Lotus leaf was determined as 1.5:0.3:0.2, resulting in a water extract with high levels of total triterpenes, flavonoids, and polysaccharides. The developed compounded tea exhibited a mellow, fresh, and natural taste.

(2) In this study, Qingqian Liu Moringa tea was optimized to balance the sweetness of Qing Qian Liu with the green and astringent taste of Moringa and lotus leaves. Additionally, the antioxidant, hypoglycemic, and lipid-regulating properties of *Cyclocarya paliurus*

are highlighted as important for young people's health. The compounded tea developed in this study has the potential to be promoted and utilized as a health-preserving beverage.

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