SCIREA Journal of Clinical Medicine
ISSN: 2706-8870
http://www.scirea.org/journal/CM
September 12, 2022
Volume 7, Issue 5, October 2022
https://doi.org/10.54647/cm32899

Study on mineral elements and effective components of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil based on principal component analysis

Li Jin-ling [1,2], ZHAO Zhi [1,2], Luo Chun-li [1,2], Wang Hua-lei [1,2], Luo Fu-lai [1,2]

[1] Guizhou University, Guizhou Guiyang 550025, China;

[2] Guizhou Key(Engineering) Laboratory for Propagation and cultivation of Medicinal Plants, Guiyang 550025, China

Abstract

Purpose: To study the contents of mineral elements and effective components of Hook branch of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources, analyze the relationship between characteristic elements, mineral elements and effective components of hook branch and evaluate the quality of medicinal materials. **Method:** The contents of 10 essential mineral elements of hook branch from different sources were determined by ICP. Alkaloids were determined by HPLC. The characteristic elements of hook branches and comprehensive evaluation were analyzed by principal component analysis. **Results:** The content of N in hook branch was the highest with an average content of 7.38g.kg^{-1}. The content of trace element Mn was high with an average content of 2083.58mg.kg^{-1}. The variation coefficient of P element content was the biggest, and it was 44.47%. The variation coefficient of Ca element was the smallest, and it was 17.83%. There was a significant positive correlation between K and total alkaloids, Zn and isorhynchophylline, Mn and

rhynchophylline and total alkaloids. Cu was positively correlated with isorhynchophylline. Four principal components were selected to evaluate the quality of hook branch by principal component analysis. It was found that the characteristic elements of Gastrodia elata were K, Cu, CA, P, N and B. **Conclusion**: The content of N in hook branch is high and relatively stable. K. Cu, Mn and Zn were positively correlated with alkaloid metabolism. The comprehensive evaluation shows that the quality of the hook branch managed scientifically in Qiandongnan Prefecture ,Guizhou Province is good.

Keywords: *Uncaria rhynchophylla*（Miq.）Miq. ex Havil, Mineral element; Extract; Rhynchophylline; Isorhynchophylline; Principal component analysis (PCA)

Fund program: *Uncaria rhynchophylla*（Miq.）Miq. ex Havil expert team project of Guizhou Agricultural and rural department(2019); Talent base project of Organization Department in Guizhou Province (QRLF [2013] No. 15), Construction Program of Biology First-class Discipline in Guizhou(GNYL［2017］009).

1. Introduction

Uncaria rhynchophylla（Miq.）Miq. ex Havil is a traditional Chinese medicine ,which is included in the various editions of the Pharmacopoeia of the people's Republic of China. It is used as medicine with its hooked stems and branches. It has the effects of clearing heat, calming liver, calming wind and calming shock[1]. Modern pharmacological experiments have also proved that it has the effect of lowering blood pressure[2], and it could aid in the treatment of Alzheimer’s Disease[3-5]. so it has high medicinal value. Now the demand for *Uncaria rhynchophylla* is ever-increasing, while the wild resources of *Uncaria rhynchophylla* can’t meet the market requirement. Thus, artificial cultivation of *Uncaria rhynchophylla* is extremely urgent.

In recent years, the research of *Uncaria rhynchophylla* mainly focuses on chemical components [6], separation and extraction [7-8], pharmacological effects and functions [9-16], cultivation techniques [17], post harvest processing [18]. Alkaloids are the main components of *Uncaria rhynchophylla*, which have been paid more and more attention because of their wide application in medical care. At present, the research on Alkaloids mainly focuses on the

extraction and determination methods of alkaloids in hook branches[19], the regulation of alkaloid metabolism [20-21], pharmacological effects and functions [22-31], molecular biology [32], and the influence of cultivation measures on the growth of *Uncaria rhynchophylla* [33-35]. There are few reports on the cultivation environment and standardized cultivation technology of the plant. Qiandongnan Prefecture of Guizhou Province is rich in wild Uncaria resources with excellent quality. "Jianhe *Uncaria rhynchophylla*（Miq.）Miq. ex Havil " was rated as a geographical indication protection product in China in 2012. At present, the planting area of *Uncaria rhynchophylla* is more than 30000 hectares, and it is planted on barren slopes, ditches, woodlands and arable land. There is no report on which environment should be selected for cultivation and how to apply fertilizer. At present, there is no detailed report on the cultivation environment and field management that can lead to high yield and quality of *Uncaria rhynchophylla*. Therefore, the experiment provides scientific basis for the selection of high-yield and high-quality cultivation environment and the field management of fertilizer and water in the cultivation process by studying the content of mineral elements, extracts and alkaloids in the hook branches from different sources, and conducting relevant analysis and comprehensive evaluation.

2. Materials and Methods

2.1 Materials

The test materials were from 17 *Uncaria rhynchophylla*（Miq.）Miq. ex Havil bases in Guizhou Province. The detailed information is shown in Table 1. The 6-8-year-old *Uncaria rhynchophylla* were collected in November 2020 and taken back to the laboratory.

Table 1 sample information of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil.

number	source	Tree age (year)	Management
1	Gedong Town, Jianhe County, Qiandongnan Prefecture	6	Proper management
2	Liuchuan Town, Jianhe County, Qiandongnan Prefecture	7	Scientific management
3	Taiyong Township, Jianhe County, Qiandongnan Prefecture	6	Scientific management
4	Jiuyang Town, Jianhe County, Qiandongnan Prefecture	8	Extensive management
5	Nanshao Town, Jianhe County, Qiandongnan Prefecture	7	Proper management

6	Lipingbazhai Township, Qiandongnan Prefecture	6	Natural growth
7	Hongzhou Town, Liping County, Qiandongnan Prefecture	6	Scientific management
8	Deshun Township, Liping County, Qiandongnan Prefecture	6	Proper management
9	Lantian Town, Tianzhu County, Qiandongnan Prefecture	7	Scientific management
10	Xingren Town, Danzhai County, Qiandongnan Prefecture	6	Natural growth
11	Nanbai Town, Zunyi County, Zunyi City	6	Proper management
12	No. 1, Zhengchang Town, Suiyang County, Zunyi City	6	Extensive management
13	No. 2, Zhengchang Town, Suiyang County, Zunyi City	6	Scientific management
14	No. 3, Zhengchang Town, Suiyang County, Zunyi City	7	Natural growth
15	No. 4, Zhengchang Town, Suiyang County, Zunyi City	7	Extensive management
16	Zhongxin Town, Daozhen County, Zunyi City	7	Natural growth
17	Baisha Township, Pu an County, Southwest Guizhou	6	Extensive management

2.2 Design

The experiment was conducted in the Guizhou Key Laboratory for Propagation and cultivation of Medicinal Plants from 2020 to 2021.The hook branches of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources were washed with water and then washed with deionized water. After controlling the moisture of the epidermis, they were segmented by stainless steel scissors.They were dried at 50℃ to constant weight, and crushed through a 0.5mm sieve.

2.3 Measuring method

N element content was determined by Kjeltec 8400 Kjeltec nitrogen analyzer (FOSS company) using Kjeltec nitrogen determination method. The contents of P, K, Ca, Mg, Fe, Zn, B, Mn and Cu were determined by optima 8100 inductively coupled plasma emission spectrometer (Perkin Elmer). Extract content was measured according to methods stipulated in Part I of *Chinese Pharmacopoeia* 2020 edition[1]. Rhynchophylline and isorhynchophylline were determined by HPLC[36].Each sample was repeated 3 times

2.4 Data analysis

Data statistic analysis was made by the software of Excel 2007 and SPSS13.0.

3. Results

3.1 Mineral element content in Hook branch of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources.

The contents of N, P, K, CA, Mg, Fe, Zn, B, Mn and Cu in the hook branches of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources was Table 2 and table 3. Among macroelements and medium element, the content of N element was the highest, with an average content of 7.38g.kg^{-1}. The second was Ca, with an average content of 0.59 g.kg^{-1}. Next, the average content of K element was 0.58 g.kg^{-1}, the average content of P element was 0.14 g.kg^{-1}, and the average content of Mg element was 0.12 g.kg^{-1}.

Among the 10 mineral elements, the variation coefficient of Ca content in hook branch was the smallest, which was 17.38%, and the content range was 0.43-0.75 g.kg^{-1}. The second was N, the coefficient of variation was 22.64%, and the content ranges from 5.25 to 12.00 g.kg^{-1}. Moreover, the contents of the two elements were both high in the hook branch, indicating that there must be a certain amount of Ca and N elements in the growth of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil. Ca and N elements were easy to become the minimum limiting factors affecting the growth of the plant.

The variation coefficient of P element content was the biggest, and it was 44.47%. It showed that the variation degree of P element content in different sources was the bigges., The variation range of P element content was 0.05-0.29 g.kg^{-1}. The large variation range of P content may be related to the large variation of soil P supply. The soil P in the *Uncaria rhynchophylla*（Miq.）Miq. ex Havil. production base is deficient[37]. The difference in the supply and availability of phosphorus fertilizer in different production bases is large, resulting in the large difference in plant P content.

Table 2 contents of macroelement and medium elements in hook branches of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources （g.kg^{-1}）

Sample	N	P	K	Ca	Mg
1	5.25±0.09	0.21±0.01	0.71±0.02	0.56±0.2	0.13±0.01
2	12.00±0.12	0.16±0.02	0.58±0.01	0.73±0.03	0.19±0.01
3	7.50±0.08	0.29±0.01	0.61±0.02	0.72±0.03	0.14±0.00
4	5.69±0.05	0.06±0.01	0.58±0.03	0.43±0.02	0.11±0.01
5	7.18±0.09	0.05±0.01	0.64±0.01	0.53±0.01	0.11±0.01

6	6.31±0.07	0.14±0.01	0.28±0.02	0.52±0.02	0.11±0.01
7	7.97±0.11	0.10±0.02	0.93±0.06	0.59±0.02	0.12±0.00
8	7.46±0.05	0.10±0.01	0.69±0.02	0.46±0.01	0.17±0.01
9	7.16±0.09	0.13±0.02	0.68±0.03	0.70±0.02	0.18±0.02
10	5.84±0.06	0.11±0.01	0.76±0.04	0.47±0.01	0.12±0.01
11	8.05±0.10	0.13±0.01	0.64±0.02	0.75±0.02	0.11±0.01
12	8.10±0.12	0.09±0.01	0.48±0.01	0.54±0.03	0.09±0.01
13	9.46±0.08	0.14±0.02	0.61±0.01	0.69±0.02	0.12±0.00
14	6.24±0.05	0.16±0.02	0.37±0.02	0.53±0.01	0.08±0.00
15	8.31±0.06	0.16±0.02	0.44±0.03	0.67±0.02	0.11±0.00
16	5.28±0.03	0.24±0.03	0.46±0.01	0.53±0.01	0.14±0.01
17	7.65±0.05	0.10±0.01	0.37±0.02	0.57±0.02	0.09±0.00
Average value	7.38	0.14	0.58	0.59	0.12
Maximum	12.00	0.29	0.93	0.75	0.19
Minimum	5.25	0.05	0.28	0.43	0.08
Range	6.75	0.24	0.65	0.32	0.11
Coefficient variation	22.64	44.47	28.19	17.38	24.90

Among the trace elements, the content of Mn was the highest ,with an average content of 2083.58 mg kg^{-1}. Secondly, the average contents of Fe and Zn were similar. The content of element B was the third. The content of Cu was the lowest, with an average content of 75.03 $mg.kg^{-1}$.

The content of Mn element was high, and the coefficient of variation was 39.09%, which indicated that the content of Mn element in Uncaria hook from different sources varied greatly. The content of Mn element varied from 332.72 mg kg^{-1} to 3409.91 mg kg^{-1}. Compared with other woody plants such as apple and peach [38], *Uncaria rhynchophylla*（Miq.）Miq. ex Havil has a special ability to enrich Mn trace elements.

The contents of Fe and Zn in different sources were higher, the average content of Fe was 395.23 $mg{\cdot}kg^{-1}$, and the average content of Zn was 392.17 $mg{\cdot}kg^{-1}$. *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources belong to plants with high contents of Fe and Zn elements. The distribution of Fe elements on the earth's surface is very uneven. There are great differences in Fe elements in different ecological environments, which may lead to large

differences in the content of Fe elements in hook branches from different sources. The variation coefficient of Zn element content was small, and it was 24.99%, while the content of Zn element was high, which may be related to the accumulation of effective components of *Uncaria rhynchophylla*.

Table 3 contents of microelemen elements in hook branches of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources （mg.kg^{-1}）

Sample	Cu	Fe	Mn	Zn	B
1	101.71±1.23	330.61±2.34	2597.50±21.37	470.00±3.12	158.11±4.32
2	106.42±2.18	423.64±4.12	1648.21±15.24	588.21±5.69	120.62±2.89
3	97.23±1.08	506.82±3.53	2464.61±16.32	483.54±3.85	151.73±5.16
4	55.21±0.56	407.61±3.96	2443.00±20.24	514.32±4.25	146.63±3.24
5	83.22±0.43	445.34±2.29	2189.91±15.98	445.61±5.87	156.00±4.59
6	48.61±0.76	575.44±3.12	1430.62±23.12	368.34±4.68	51.42±2.48
7	97.93±0.89	622.21±5.84	2233.63±18.34	346.04±2.95	221.71±6.45
8	57.72±0.82	358.13±4.23	3409.91±24.15	455.32±10.32	97.04±2.01
9	94.83±1.34	515.71±3.87	3342.54±36.94	436.54±8.78	168.91±5.76
10	89.72±1.56	335.63±2.15	1776.91±15.94	411.51±12.34	38.93±0.86
11	105.51±2.08	489.61±1.94	1234.14±25.83	266.63±9.48	168.62±4.15
12	57.62±1.02	192.04±2.76	2582.62±36.15	315.74±5.96	164.41±3.52
13	39.63±0.56	454.72±5.18	1182.14±20.16	280.04±13.24	189.43±4.89
14	50.33±0.42	225.51±3.79	1341.21±15.32	284.41±9.54	140.51±2.96
15	44.84±0.35	235.31±2.96	2749.51±22.13	311.52±14.79	162.12±5.18
16	71.83±0.92	279.22±3.79	332.72±5.78	437.23±16.34	21.21±0.56
17	73.22±0.88	321.40±5.67	2461.63±29.32	251.81±9.12	119.90±1.02
Average value	75.03	395.23	2083.58	392.17	133.96
Maximum	106.42	622.21	3409.91	588.21	221.71
Minimum	39.63	192.04	332.72	251.81	21.21
Range	66.79	430.17	3077.19	336.40	200.50
Coefficient variation	31.26	31.66	39.09	24.99	40.37

3.2 Extract and alkaloid contents in Hook branch of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources.

The coefficient of variation of isorhynchophylline content was the largest, reaching 77.89%, and the content variation range was 0.0040% - 0.0447%. It was showed that the content of isorhynchophylline in different sources was different. The coefficient of variation of total alkaloids and rhynchophylline were the second. The coefficient of variation of extract content was the smallest, and it was 29.62%. The Pharmacopoeia stipulates that the extract of Hook branch should not be less than 6.0%, and the extract contents of the different sources meet the standard. They rang from 7.55% to 24.33%.

Table 4contents of extracts and alkaloids in hook branches of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources （%）

Sample	Extract	Rhynchophylline	Isorhynchophylline	total alkaloids
1	12.8229±1.84	0.0874±0.0021	0.0214±0.0008	0.1088
2	24.2039±1.32	0.0406±0.0012	0.0421±0.0012	0.0827
3	20.5112±0.44	0.0505±0.0034	0.0447±0.0016	0.0952
4	24.3341±0.26	0.0634±0.0026	0.0130±0.0009	0.0764
5	18.9961±0.31	0.0801±0.0031	0.0321±0.0010	0.112
6	18.1376±0.69	0.0356±0.0019	0.0060±0.0012	0.0416
7	12.7670±0.92	0.0787±0.0022	0.0364±0.0008	0.1151
8	16.3455±1.99	0.0902±0.0012	0.0132±0.0005	0.1034
9	13.0020±0.71	0.0381±0.0009	0.0158±0.0009	0.0539
10	10.4198±1.54	0.0304±0.0011	0.0088±0.0006	0.0392
11	13.4089±0.48	0.0131±0.0008	0.0050±0.0004	0.0181
12	16.8787±1.75	0.0559±0.0042	0.0112±0.0006	0.0671
13	23.4453±1.79	0.0493±0.0023	0.0059±0.0003	0.0552
14	7.5548±1.13	0.0246±0.0031	0.0089±0.0004	0.0335
15	24.0865±1.58	0.0391±0.0016	0.0040±0.0004	0.0431
16	20.4319±1.64	0.0230±0.0027	0.0057±0.0005	0.0287
17	20.2532±1.51	0.0528±0.0031	0.0203±0.0008	0.0731
Average value	17.51	0.0502	0.0173	0.0675
Maximum	24.33	0.0902	0.0447	0.1151
Minimum	7.55	0.0131	0.0040	0.0181

Range	16.78	0.0771	0.0407	0.0970
Coefficient variation	29.62	46.33	77.89	46.67

3.3 Correlation analysis of components in the hook branches of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources

There are certain correlations among the mineral elements, extracts and alkaloid contents in the hook branches of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources, some of which reach significant or extremely significant levels, as shown in Table 5. N and Ca, Mg and Zn, isorhynchophylline and Cu, total alkaloids and rhynchophylline and isorhynchophylline all reached extremely significant positive correlation. K and Cu and total alkaloids， Mn and Rhynchophylline and total alkaloids， Isorhynchophylline and Zn all reached significant positive correlation. K. Mn, Cu and Zn are closely related to the formation and accumulation of alkaloids.

Table 5 Correlation of components in different parts of *Pueraria thomsonii* Benth. Roots

correlation coefficient	N	P	K	Ca	Mg	Cu	Fe	Mn	Zn	B	Extract	Rhynchophylline	Isorhynchophylline	total alkaloids
N	1.0000													
P	-0.0794	1.0000												
K	0.0659	-0.1411	1.0000											
Ca	0.6507**	0.4163	0.0857	1.0000										
Mg	0.3408	0.2613	0.3957	0.3191	1.0000									
Cu	0.1475	0.2038	0.5983*	0.3826	0.4340	1.0000								
Fe	0.1545	-0.0462	0.4112	0.3110	0.3185	0.4105	1.0000							
Mn	0.0290	-0.2815	0.2948	-0.0626	0.2364	0.0536	0.0118	1.0000						
Zn	0.0228	0.1780	0.3098	-0.104	0.7171**	0.4226	0.1903	0.1870	1.0000					
B	0.3712	-0.2080	0.4014	0.4487	-0.1127	0.1362	0.2444	0.3899	-0.2214	1.0000				
Extract	0.4257	0.0501	-0.2880	0.1901	0.1679	-0.2736	0.0063	-0.0396	0.256	-0.0063	1.0000			
Rhynchophylline	-0.0467	-0.2944	0.4528	-0.3566	0.1222	0.0393	0.1127	0.6016*	0.3163	0.3591	0.0796	1.0000		
Isorhynchophylline	0.3768	0.171	0.4008	0.2795	0.3713	0.6258**	0.4036	0.2438	0.5285*	0.3112	0.1366	0.4301	1.0000	
total alkaloids	0.1270	-0.1440	0.5059*	-0.1434	0.2493	0.2971	0.2561	0.5484*	0.4598	0.3983	0.1173	0.9222**	0.7458**	1.0000

Note:Critical value of correlation coefficient. a = 0.05, r = 0.4821. a = 0.01, r = 0.6055.

3.4 Principal component analysis and comprehensive evaluation of different source hook branch of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil.

While making the principal component analysis (PCA) for mineral element, extract and alkaloid indexes in hook branch of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil, there were 4 principal components with the eigenvalue of more than 1.0000. As shown in Table 6, the variance contribution rates of 4 principal components were 31.3314%, 18.4184%, 13.6336% and 11.7461% respectively. The cumulative contribution rate of the former 4 principal components was up to 75.1296%, i.e. 4 principal components represent 82.9940% information of 14 indexes in 17 source hook branch.

Table 6 Eigenvalues, variance contribution rate and accumulative variance contribution

Principal component	Eigenvalues	Variance contribution rate（%）	Accumulative variance contribution（%）
1	4.3864	31.3314	31.3314
2	2.5786	18.4184	49.7498
3	1.9087	13.6336	63.3834
4	1.6445	11.7461	75.1296

The eigenvalue of the first principal component was 4.3864, and the variance contribution rate was 31.3314%. From Table 8, The contents of isorhynchophylline, total alkaloids, K ,rhynchophylline and Cu had higher load on the first principal component, which indicated that the first principal component mainly reflects the information of indexes, such as Isorhynchophylline, total alkaloids,K , Rhynchophylline and Cu. The eigenvalue of the second principal component was 2.5786, and the variance contribution rate was 18.4184%. The contents of Ca, P, and N had higher load on the second principal component, indicating that the second principal component mainly reflects the information of indexes, such as Ca, P, and N. The eigenvalue of the third principal component was 1.9087, and the variance contribution rate was 13.6336%. The content of B, N and Ca had higher load on the third principal component, indicating that the third principal component mainly reflects the information of indexes, such as B, N and Ca. The eigenvalue of the fourth principal component was 1.6445, and the variance contribution rate was 11.7461%. The extract content had higher load on the third principal component, indicating that the third principal component mainly reflects the information of the extract content.It could be ascertained that the indexes including the contents of isorhynchophylline, total alkaloids,K, rhynchophylline,

Cu, Ca, P, N, B and extract, represented the information of mineral elements and components contents in hook branch of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil based on the load of different indexes on each factor. From the eigenvector of the principal component of each index, the principal component of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil in different sources was mainly the isorhynchophylline, total alkaloids,K, rhynchophylline, Cu, Ca, P, N, B and extract index.

Table 7 Characteristics of the principal component vectors of the index

Source	U1	U2	U3	U4
N	0.1737	0.3048	0.3844	0.2841
P	-0.0067	0.3743	-0.2623	0.0005
K	0.3411	-0.0783	-0.0159	-0.3663
Ca	0.1279	0.4995	0.3325	-0.0452
Mg	0.2876	0.2452	-0.2862	0.1373
Cu	0.3052	0.2252	-0.1573	-0.3787
Fe	0.2458	0.1505	0.0543	-0.2181
Mn	0.2429	-0.3025	0.1199	0.089
Zn	0.2875	0.0513	-0.4749	0.2302
B	0.2218	-0.0586	0.5605	-0.1228
Extract	0.0454	0.1391	0.0882	0.6739
Rhynchophylline	0.3053	-0.4225	0.0134	0.1496
Isorhynchophylline	0.3976	0.0951	-0.0311	0.054
total alkaloids	0.3956	-0.2711	-0.0034	0.1335

The four principal components were used to assess the mineral elements and components indexes of hook branch in *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources. The comprehensive assessment function is F=0.4386×F1+0.2579×F2+0.1903×F3+0.1645×F4. The principal component values, comprehensive component scores and sorts of the mineral elements and components indexes of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil from different sources were calculated by the comprehensive assessment function, as shown in Table 8.

The first three samples among 17 samples were the samples with the number2, 3 and 7, which came from Qiandongnan Prefecture, and adopted scientific management from table 1. The

first and second was the sample from Liuchuan and Taiyong Town, Jianhe County, Qiandongnan Prefecture,GuiZhou Province, where affiliated to "Jianhe *Uncaria rhynchophylla*（Miq.）Miq. ex Havil" national geographical indication product protection area. The synthesis scores of the sources ranking the first was far above the other sourcess. The synthesis scores of components in the first three samples were positive, and the comprehensive scores are all greater than 1. It was thus clear that, the quality formation of of medicinal materials *Uncaria rhynchophylla*（Miq.）Miq. ex Havil needed suitable environment and scientific management of cultivation

Table 8 Synthesis scores of components and comprehensive composition

Sample	F1	F2	F3	F4	F	Sorting
1	1.8733	-1.3151	-1.2696	-0.9224	0.0884	7
2	3.0864	3.3102	-0.5099	1.8944	2.4217	1
3	2.6025	2.031	-0.6714	0.2067	1.5711	2
4	0.069	-2.1183	-0.5581	1.2375	-0.4190	12
5	1.8368	-1.7695	0.2863	0.3511	0.4617	6
6	-2.4448	0.2458	-0.9131	0.4433	-1.1103	14
7	3.3781	-0.942	1.2992	-1.9853	1.1601	3
8	1.5864	-2.3196	-1.0795	0.976	0.0520	8
9	1.5683	0.8752	0.0456	-1.1117	0.7394	4
10	-1.2865	-0.5251	-1.9798	-1.809	-1.3752	16
11	-1.0873	2.3032	1.5075	-2.4277	0.0055	9
12	-1.2183	-1.4737	1.2993	0.5828	-0.5705	13
13	-0.8258	1.0156	2.2916	0.8826	0.4824	5
14	-3.4233	-0.4231	0.3342	-1.2417	-1.7510	17
15	-1.7614	0.3118	1.6634	1.6946	-0.0958	10
16	-2.8066	1.6084	-2.9354	0.4739	-1.2986	15
17	-1.1469	-0.815	1.1899	0.7548	-0.3619	11

4. Discussion

N element is a necessary mass element for plant growth. The content of N element in 17 different sources of the hook branches was high and the coefficient of variation was low, which indicated that the variation range of N element content was relatively narrow.The

content of N element was relatively stable, and it indicated that a certain amount of N element was the necessary condition for the yield and quality of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil. The hook branch contains alkaloids, mainly rhynchophylline and isorhynchophylline, which are secondary metabolites containing nitrogen and may be related to nitrogen metabolism [39].

According to the principal component analysis, the coefficient of K element in the first principal component of mineral elements was the biggest. It can be seen that the correlation between K element and principal component was the highest. The first principal component mainly reflected the characteristics of K element. Element K is one of the three elements of plant growth, known as "quality element". It participates in growth and primary metabolism, and is a key element in the formation of yield and quality of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil.

The content of Mn in trace elements was high. The content of Mn was significantly positively correlated with the contents of rhynchophylline and total alkaloids. It is possible that the hook branch has special enrichment ability of Mn trace elements and is related to alkaloid metabolism. In the next step, we can further study the relationship between manganese and alkaloid metabolism.

Among the 17 medicinal materials from different sources, the top three were Liuchuan Town, Jianhe County, Taiyong Town, Jianhe County and Hongzhou Town, Liping County, Qiandongnan Prefecture. Scientific field management was adopted for the three Uncaria species. From the comprehensive ranking, the hook branch shows the characteristics of regional differences and scientific field management.

Mineral elements are the material basis for plant growth, and can also be used as the catalyst for the synthesis reaction of some organic substances in plants. At the same time, mineral elements also participate in the structure and function of plant effective components and affect the formation and accumulation of plant chemical components. The relationship between mineral elements and metabolism of secondary metabolites such as rhynchophylline and isorhynchophylline needs to be studied systematically.

5. Conclusion

The content of N element in different source hook branch of *Uncaria rhynchophylla*（Miq.）Miq. ex Havil. is high and relatively stable. The variation coefficient of P element is large.

The characteristic elements of hook branch are k, Cu, CA, P, N and B. K. Cu, Mn and Zn are positively correlated with alkaloid metabolism. From the comprehensive evaluation of hook branch, *Uncaria rhynchophylla*（Miq.）Miq. ex Havil shows the characteristics of regional differences and scientific field management.

Acknowledgments

We thank for Guizhou Key Laboratory of Propagation and Cultivation of Medicinal Plants (Guiyang, Guizhou, China) providing research platform. We are grateful to all of the members of our laboratories who provided help of experiment.

Compliance with ethics guidelines

LI Jin-ling, ZHAO Zhi,Luo Chun-li, Wang Hua-lei and Luo Fu-lai declare that they have no conflict of interest.

This article does not contain any studies with human or animal subjects performed by any of the authors.

Reference

[1] Chinese Pharmacopoeia Commission.Chinese Pharmacopoeia 2020 edition. Beijing, Chinese Medical Science and Technology Publishing House 2020;p.302.

[2] Li Haojv,Wei Wenlong,Li Zhenwei,Wang Mengyuan,Wei Xuemei,Cheng Mengzhen, et al. An enhanced strategy integrating offline two-dimensional separation with data independent acquisition mode and deconvolution: Characterization of metabolites of Uncaria rhynchophylla in rat plasma as a case. Journal of Chromatography B2021;1181.

[3] Zeng Peng,Su Hong Fei,Ye Chao Yuan,Qiu Shuo Wen,Tian Qing. Therapeutic Mechanism and Key Alkaloids of Uncaria rhynchophylla in Alzheimer's Disease From the Perspective of Pathophysiological Processes. Frontiers in Pharmacology2021;12.

[4] Xu Qing Qing,Shaw Pang Chui,Hu Zhen,Yang Wen,Ip Siu Po,Xian Yan Fang, et al. Comparison of the chemical constituents and anti-Alzheimer's disease effects of Uncaria rhynchophylla and Uncaria tomentosa. Chinese Medicine2021;16(1).

[5] Zeng Peng,Wang XiaoMing,Ye ChaoYuan,Su HongFei,Tian Qing. The Main Alkaloids in <italic>Uncaria rhynchophylla</italic> and Their Anti-Alzheimer's Disease Mechanism Determined by a Network Pharmacology Approach. International Journal of Molecular Sciences2021;22(7).

[6] Zhang Yaowen,Xu Jinqi,Tian Zhenhua,Chen Zhenshan. Chemical Constituents of Uncaria rhynchophylla. Chemistry of Natural Compounds2022;58(1).

[7] Liang XinXin,Yang JinXuan,Li JianMei,Huang JiaBi,Yang LiuMeng,Sun TianTian, et al. A pair of new oxindole alkaloids isolated from Uncaria macrophylla.. Natural product research2021.

[8] Abral Hairul,Ikhsan Muhammad,Rahmadiawan Dieter,Handayani Dian,Sandrawati Neny,Sugiarti Eni, et al. Anti-UV, antibacterial, strong, and high thermal resistant polyvinyl alcohol/Uncaria gambir extract biocomposite film. Journal of Materials Research and Technology2022;17.

[9] Zhang Xinyue,Wang Shuo,Shu Lexin,Zhao Shan,Yan Xingxu,Jia Guoxiang, et al. Rapid screening of hepatotoxic components in Uncariae Ramulus Cum Uncis based on "component-target-pathway" network. Journal of Pharmaceutical and Biomedical Analysis2022;219.

[10] Abral Hairul,Kurniawan Arif,Rahmadiawan Dieter,Handayani Dian,Sugiarti Eni,Muslimin Ahmad Novi. Highly antimicrobial and strong cellulose-based biocomposite film prepared with bacterial cellulose powders, Uncaria gambir, and ultrasonication treatment. International journal of biological macromolecules2022;208.

[11] Xie Lingling,Wang Tianyi,Lin Shan,Lu Zhuqing,Wang Yilian,Shen Zhiqing, et al. Uncaria Rhynchophylla attenuates angiotensin II-induced myocardial fibrosis via suppression of the RhoA/ROCK1 pathway. Biomedicine & Pharmacotherapy2022;146.

[12] Khan Afaq Ullah,Nazir Sadia,ElKeblway Ali,Tahir Kamran,AbdelHafez Shams H,AlAbdulkarim Hessah A, et al. Uncaria rhynchophylla mediated Ag/NiO nanocomposites: A new insight for the evaluation of cytotoxicity, antibacterial and photocatalytic applications. Photodiagnosis and photodynamic therapy2021;37.

[13] Yu ZhenLong,Bai Rong,Zhou JunJun,Huang HuiLian,Zhao WenYu,Huo XiaoKui, et al.

Uncarialins J—M from Uncaria rhynchophylla and Their Anti-depression Mechanism in Unpredictable Chronic Mild Stress-Induced Mice via Activating 5-HT1A Receptor. Chinese Journal of Chemistry2021;39(5).

[14] Shin MiRae,Kim Min Ju,Lee Jin A,Roh SeongSoo. Effect of Uncaria rhynchophylla against Thioacetamide-Induced Acute Liver Injury in Rat. Canadian journal of gastroenterology & hepatology2021.

[15] Yang Zhong-Duo,Li Zhi-Jie,Zhao Jun-Wen,Sun Jian-Hui,Yang Li-Jun,Shu Zong-Mei. Secondary Metabolites and PI3K Inhibitory Activity of Colletotrichum gloeosporioides, a Fungal Endophyte of Uncaria rhynchophylla. Current microbiology2019;76(7).

[16] Chang-An Geng,Tong-Hua Yang,Xiao-Yan Huang,Yun-Bao Ma,Xue-Mei Zhang,Ji-Jun Chen. Antidepressant potential of Uncaria rhynchophylla and its active flavanol, catechin, targeting melatonin receptors. Journal of Ethnopharmacology2019;232.

[17] Deng Xiaohong, Ji Lala, Xiong Lulu, Wang Jianjian. Effects of different altitudes on the growth and alkaloid content of Uncaria Uncaria. Journal of plant physiology2020;56 (10): 2095-2102. Doi: 10.13592/j.cnki.ppj.2020.0307

[18] Luo Ming, Wei Qidi, Yang Donghong, Huo Ke, long Mingcheng, Ren Xiujuan, et al. Effects of different drying conditions on the content of active ingredients in Uncaria Uncaria. Molecular plant breeding2022;1-11[2022-08-24].http://kns.cnki.net/kcms/detail/46.1068.S.20220224.1930.026.html

[19] Yin Tianpeng,Lu Jingguang,Liu Qinghua,Zhu Guoyuan,Zhang Wei,Jiang Zhihong. Validated Quantitative ¹H NMR Method for Simultaneous Quantification of Indole Alkaloids in Uncaria rhynchophylla.ACS omega2021;6(47).

[20] Zhou HaoFeng,Li WenYan,Peng LiYan,Li XiaoNian,Zuo ZhiLi,Zhao QinShi. Rhynchines A-E: Ca_v3.1 Calcium Channel Blockers from Uncaria rhynchophylla. Organic letters2021.

[21] Li Hao Jv,Wei Wen Long,Li Zhen Wei,Yao Chang Liang,Wang Meng Yuan,Zhang Jian Qing, et al. Systematic comparison of metabolic differences of Uncaria rhynchophylla in rat, mouse, dog, pig, monkey and human liver microsomes. Analytical and bioanalytical chemistry2020;412.

[22] Kushida Hirotaka,Matsumoto Takashi,Ikarashi Yasushi. Properties, Pharmacology, and Pharmacokinetics of Active Indole and Oxindole Alkaloids in Uncaria Hook. Frontiers in Pharmacology2021;12.

[23] Duchnowicz Piotr,Pilarski Radosław,Michałowicz Jaromir,Bukowska Bożena. Changes in Human Erythrocyte Membrane Exposed to Aqueous and Ethanolic Extracts from Uncaria tomentosa. Molecules (Basel, Switzerland)2021;26(11).

[24] Zheng Meizhu,Chen Minghui,Liu Chunming,Fan Yajun,Shi Dongfang. Alkaloids extracted from Uncaria rhynchophylla demonstrate neuroprotective effects in MPTP-induced experimental parkinsonism by regulating the PI3K/Akt/mTOR signaling pathway. Journal of Ethnopharmacology2021;266.

[25] Liang Jia-Hao,Luan Zhi-Lin,Tian Xiang-Ge,Zhao Wen-Yu,Wang Ya-Li,Sun Cheng-Peng, et al. Correction to Uncarialins A-I, Monoterpenoid Indole Alkaloids from Uncaria rhynchophylla as Natural Agonists of the 5-HT_{1A} Receptor. Journal of natural products2020;83(7).

[26] Lim Heung Bin,Lee Hyeong Ryeol. Safety and biological activity evaluation of Uncaria rhynchophylla ethanolic extract. Drug and chemical toxicology2020;45(2).

[27] Yue WANG,Qing-Lan GUO,Ruo-Fei LI,Cheng-Bo XU,Cheng-Gen ZHU,Jian-Gong SHI. Two folate-derived analogues from an aqueous decoction of Uncaria rhynchophylla. Chinese Journal of Natural Medicines2019;17(12).

[28] Guo Qiang,Si Xiali,Shi Yuntao,Yang Hongshuai,Liu Xinyu,Liang Hong, et al. Glucoconjugated Monoterpene Indole Alkaloids from Uncaria rhynchophylla. Journal of natural products2019;82(12).

[29] Liang Jia-Hao,Luan Zhi-Lin,Tian Xiang-Ge,Zhao Wen-Yu,Wang Ya-Li,Sun Cheng-Peng, et al. Uncarialins A-I, Monoterpenoid Indole Alkaloids from Uncaria rhynchophylla as Natural Agonists of the 5-HT_{1A} Receptor. Journal of natural products2019;82(12).

[30] Yitong Xie,Di Wei,Tian Hu,Yajing Hou,Yuanyuan Lin,Huaizhen He, et al. Anti-pseudo-allergic capacity of alkaloids screened from Uncaria rhynchophylla. New Journal of Chemistry2020;44(1).

[31] Wu Liang-Zhi,Xiao Xiao-Min. Evaluation of the effects of Uncaria rhynchophylla

alkaloid extract on LPS-induced preeclampsia symptoms and inflammation in a pregnant rat model. Brazilian journal of medical and biological research = Revista brasileira de pesquisas medicas e biologicas2019;52(6).

[32] Qiao Yan-Ling,Zhou Jun-Jun,Liang Jia-Hao,Deng Xiao-Peng,Zhang Zhan-Jun,Huang Hui-Lian, et al. Uncaria rhynchophylla ameliorates unpredictable chronic mild stress-induced depression in mice via activating 5-HT1A receptor: Insights from transcriptomics. Phytomedicine2021;81.

[33] Wang Xiao Hong,Li Xue,Qiang Wei,Yu Xiao Song,Zheng Hao Jie,Zhang Ming Sheng. Comparative transcriptome analysis revealed the molecular mechanism of the effect of light intensity on the accumulation of rhynchophylline and isorhynchophylline in Uncaria rhynchophylla. Physiology and Molecular Biology of Plants2022;28(2).

[34] Zhou Hao, Qiang Wei, Ao Wenwen, Lu Xingxing, Liao Haimin, Li Xue, et al. Effect of exogenous abscisic acid on alkaloid synthesis in Uncaria Uncaria. Molecular plant breeding2022;1-15. http://kns.cnki.net/kcms/detail/46.1068.S.20210816.1404.006.html

[35] Lu Xingxing, Qiang Wei, Fu Wei, Ao Wenwen, Zhou Hao, Tan aijuan, et al. Effect of Methyl Jasmonate on alkaloid synthesis of Uncaria Uncaria. Molecular plant breeding2022;1-17. http://kns.cnki.net/kcms/detail/46.1068.s.20210603.1049.004.html

[36] Li Jinling, Zhao Zhi, long Anlin, Wu Changhai, Liu Hongchang, Wang Hualei, et al. Quality analysis and evaluation of Uncaria hook from different sources in Guizhou. Guizhou Agricultural Science2013;41 (03): 40-42

[37] Zhang Chunchun, Zhang Zhenming, Zeng Xuanping, Liu Lian, Zhou Xinwei, Zhang Qinghai, et al. Distribution characteristics of soil carbon, nitrogen and phosphorus in the root zone and non root zone of the local rattan in Guizhou. Chinese herbal medicine2017;40 (11): 2491-2495. Doi: 10.13863/j.issn1001-4454.2017.11.001

[38] Zhejiang Agricultural University. Plant nutrition and fertilizer. Beijing, China Agricultural Press2013; p.159-160.

[39] Aradhana Singh,Bhanu Pandey,Sumita Kumari,Madhoolika Agrawal. Nitrogen availability modulates CO 2 -induced responses of Catharanthus roseus : Biomass allocation, carbohydrates and alkaloids profile. Journal of Applied Research on Medicinal and Aromatic Plants2015;2(4).