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Evaluation of chemical similarity among rhizome, pseudo stem and leaf of *Musa basjoo* by UPLC-ELSD fingerprint combined with chemo metrics methods

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Abstract: Rhizoma Musa (the Rhizome of *Musa basjoo* Sied.et Zucc.) is used as a traditional medical herb of Miao nationality in Guizhou province, in China. It has the efficacy of clearing heat and detoxifying, quenching thirst, diuresis, etc. Modern pharmacological studies have shown that it has hypoglycemic, inhibition of α-glucosidase, and anti-inflammatory activity. However, when the rhizomes of *Musa basjoo* are dug up, the rhizomes are unable regenerate, and the pseudostem and leaf are discarded, which not only pollutes the environment, but also causes a huge waste of herb resources. In this study, a UPLC-ELSD fingerprint analysis with chemometric method was applied for the evaluation of chemical similarity among rhizome, pseudostem and leaf of *Musa Basjoo*. The results indicated that the combined method could efficiently analyze and compare the chemical similarity among rhizome, pseudostem, and leaf of *Musa Basjoo*. The proposed method provides the foundation for the resource substitution of the rhizome, pseudostem, and leaf of *Musa Basjoo.*

Keywords: Rhizome of *Musa basjoo*, pseudostem and leaf, UPLC-ELSD fingerprint, Cluster analysis, similarity evaluation, principal component analysis.

INTRODUCTION

Rhizoma Musa (the Rhizome of *Musa basjoo* Sied.et Zucc.) is a traditional Miao medicine in Guizhou Province (Guizhou Provincial Drug Administration, 2002; Bao *et al.,* 1999). It mainly contains saponins, phenols, cardiac glycosides, triterpenoids, volatile oil, steroids, and other chemical constituents (Sun *et al*., 2009; Zhang *et al*., 2010; Fu *et al*., 2018; Liang *et al*., 2016; Jie *et al*., 2016; Wang *et al*., 2015; Wang *et al*., 2011; Wang *et al*., 2010; Wang *et al*., 2012). It has many traditional efficacy, including heat-clearing and detoxifying, quenching thirst, and diuresis, and it used to treat febrile disease, consumptive thirst, irritancy, edema, jaundice, carbuncle, furunculosis etc. (Guizhou Provincial Drug Administration, 2002). Modern pharmacological studies have shown that Rhizoma Musa has a variety of pharmacological activities such as hypoglycemia, inhibition of α-glucosidase, anti-bacterial, and anti-inflammatory activity (Qian *et al*., 2010; Wei *et al*., 2010; Zhang *et al*., 2010; Qian *et al*., 2012). At present, the studies of *Musa basjoo* mainly focus on the nutritional composition, chemical composition, and biological activity (Sardos *et al*., 2016; Wang *et al*., 2015; Pereira *et al*., 2015; Oliveira *et al*., 2016; Singh *et al*., 2016). Rhizoma Musa has a very good medicinal value. However, when the Rhizoma Musa were dug up, the *Musa basjoo* plants were unable regenerate and the pseudostem and leaf were mostly discarded, which not only pollutes the environment, but also causes a huge waste of herb resource. It has been reported that the triterpenoids in rhizoma Musa are valuable active components, and whether the triterpenoids in rhizomes, pseudostems and leaves of *Musa basjoo* are similar, and it is unclear (Xu *et al*., 2018). Therefore, it is necessary to evaluate that the pseudostem and Leaf of *Musa Basjoo* could replace the rhizomes as medicine herbs. In this paper, the fingerprints of the pseudostems, the rhizomes, and the leaves of *Musa basjoo* were compared by UPLC-ELSD combined with chemometrics method. The similarity evaluation of fingerprint, system clustering analysis and principal component analysis were performed. It also laid the foundation for the use of rhizomes, pseudostems and leaves of *Musa basjoo*.

MATERIALS AND METHODS

Materials and reagents

All samples of *Musa basjoo* were collected from different areas in China and are shown in table 1. These samples were identified by Prof. Xiangpei Wang (Guizhou University of Traditional Chinese Medicine) and stored in a cool, dry place. The voucher specimens were deposited at the Herbarium of Guizhou University of Traditional Chinese Medicine. UPLC-grade methanol and acetonitrile were purchased from TEDIA (USA). Watsons distilled

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water was purchased from Watsons Food & Beverage Co., Ltd. Products (Guangzhou, China). Other chemicals (Tianjin Kemio Chemical Reagent Co., Ltd., China) were of analytical grade reagents.

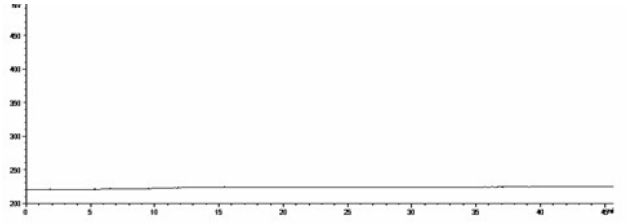

Fig. 1: methanol of UPLC chromatogram

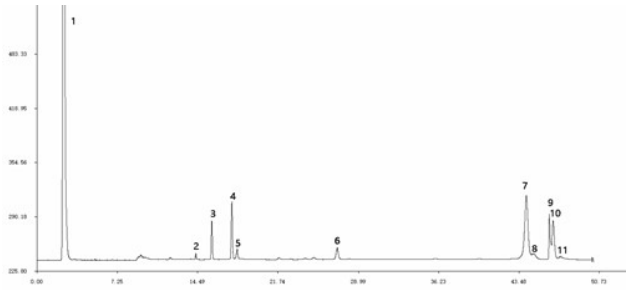

Fig. 2: UPLC-ELSD Control fingerprint of *Musa basjoo* Pseudostem

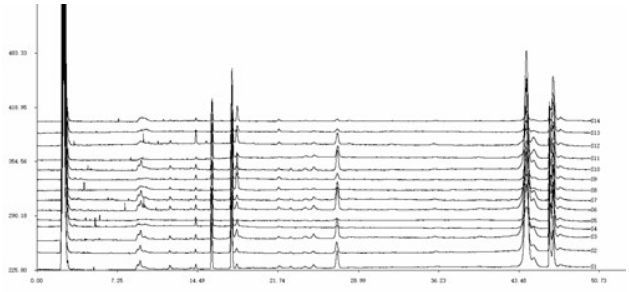

Fig. 3: UPLC-ELSD chromatogram of *Musa basjoo* Pseudostem

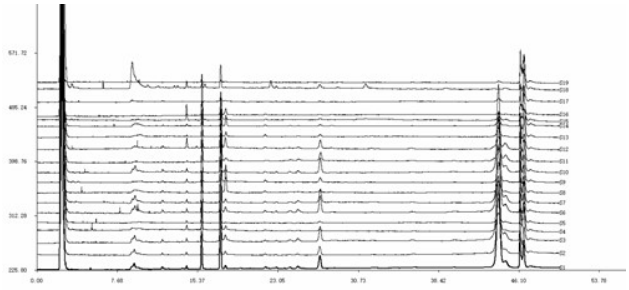

Fig. 4: chromatogram of Musa basjoo Rhizome and Pseudostem (S1-S14: Musa basjoo Pseudostem, S15-S19: Musa basjoo Rhizome)

Instrument and chromatographic conditions

Chromatographic analysis was performed on a Agilent 1290 ultra-high performance liquid chromatograph (Agilent Technology Co., Ltd., USA), equipped with a quaternary solvent delivery pump, vacuum degasser, autosampler, column oven and an evaporative light scattering detector (ELSD). The chromatographic separations were carried out on Agilent ZORBAX RRHD Eclipse plus C_{18} (2.1 × 100mm, 1.8μm, Agilent, USA). The mobile phase consisted of acetonitrile (A) and 0.1% acetic acid aqueous solution (B) with a gradient elution: 0～5 min, 5%～15%A; 5～7 min, 15%～75%A; 7～10 min, 75%～92%A; 10～25min, 92%～95%A; 25～30 min, 95%～98%A; 30～32 min, 98%～100%A; 32～46 min, 100%～100%A. The flow rate was 0.15mL/min, the sample injection volume was 1μm and the column temperature was 35°C. The drifttube temperature of the ELSD was set at 50°C with a nebulizing gas pressure of 4 bar and the spray parameter was set 40% at a gain of 500.

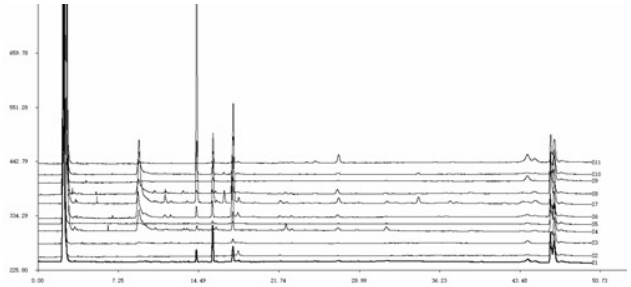

Fig. 5: UPLC-ELSD chromatogram of Rhizome and leaf of Musa basjoo (S1-S5: *Musa basjoo* Rhizome, S6-S11: *Musa basjoo* leaf)

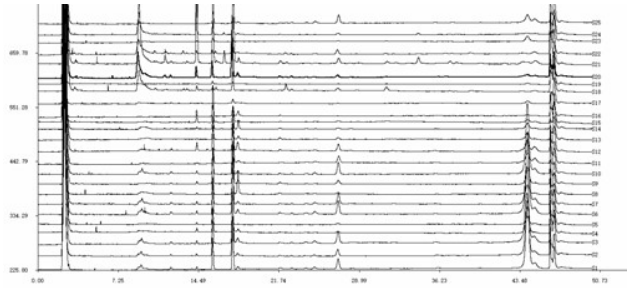

Fig. 6: UPLC-ELSD chromatogram of Musa basjoo Common peak (S1-S14: *Musa basjoo* Pseudostem; S15-S20: *Musa basjoo* Rhizome; S21-S25: Musa basjoo leaf)

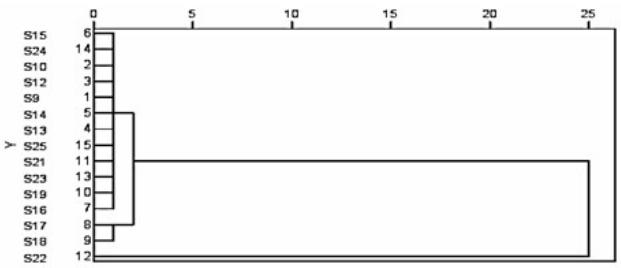

Fig. 7: Cluster Analysis of relative Peak area of *Musa basjoo* Pseudostems, Rhizome and leaf in different parts of the same Plant (Pseudostems: S9-S14, leaf: S15-S19, Rhizome: S21-S25)

Preparation of samples

All the samples were milled into powder and oven-dried

at 50°C until it reached a constant weight. The sample powder was 1.0 g, precision weighing. A 50mL volume of methanol was added to a 1.0g sample and the solution was refluxed and extracted for 3 times for each 1.5h, at a constant temperature of 60°C, respectively. The extract was filtered through filter paper and evaporated, then diluted to volume with methanol in a 1mL volumetric flask. After that, the sample solution was subsequently filtered through a 0.22μm microporous membrane and injected into the UPLC system for analysis.

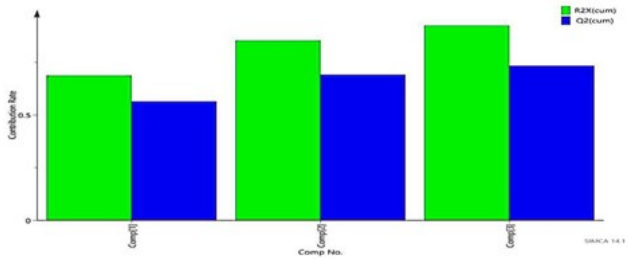

Fig. 8: relative peak area of rhizome, pseudostems and leaf in different parts of the plant Cumulative contribution rate of variance of principal component 1, 2 and 3

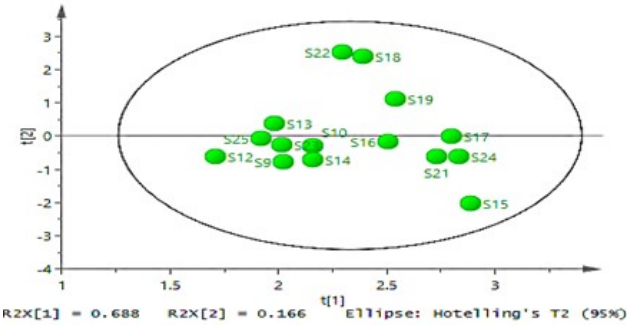

Fig. 9: Principal component PCA score diagram of relative peak area of rhizome, pseudostems and leaf in different parts of the plant

STATISTICAL ANALYSIS

Data analysis was performed by professional software named Similarity Evaluation System for Chromatographic Fingerprint of Traditional Chinese Medicine composed by Chinese Pharmacopoeia Committee (Version 2004 A), which was recommended by SFDA of China. Cluster analysis was carried out by SPSS 22. 0. statistical software (IBM Inc., USA). The principal components analysis (PCA) was performed on SIMCA 14. 0 software (Umetrics, Inc., Sweden).

RESULTS

UPLC method validation

Blank test

1μL methanol was injected into ultra-high performance liquid chromatograph. The chromatographic conditions under the Instrument and chromatographic conditions showed that methanol did not interfere with the determination. The results are shown in fig. 1.

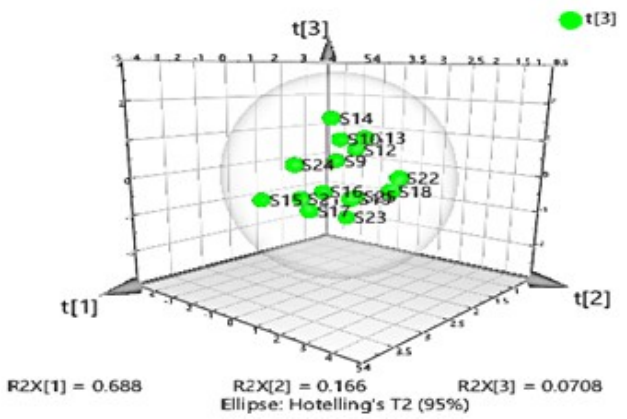

Fig. 10: Three-dimensional PCA score diagram of relative peak area of Rhizome, Pseudostems and leaf in different parts of the plant.

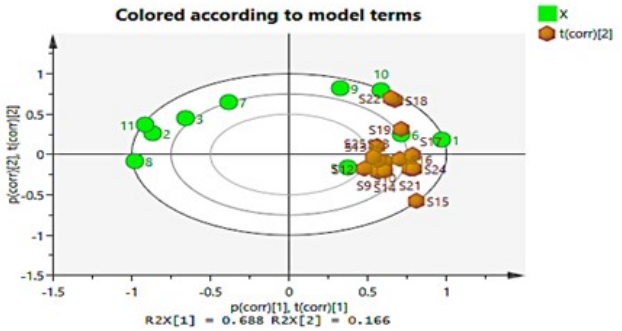

Fig. 11: Principal component PCA score and load Bipolt diagram of relative peak area of the Rhizome, Pseudostems and leaf in different parts of the plant

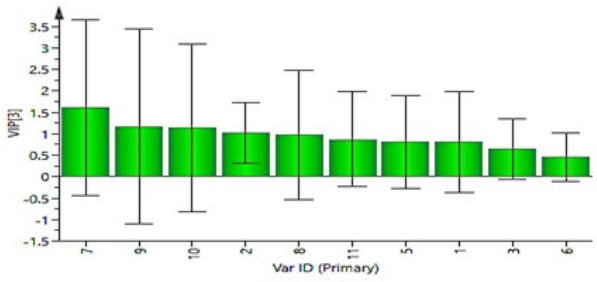

Fig. 12: VIP of different PLS-DA model markers of relative peak area of the Rhizome, Pseudostems and leaf in different parts of the plant

Precision test

The sample solution was taken for 6 times, it was determined according to the chromatographic conditions given under the Instrument and chromatographic conditions. The similarity of the six profiles was calculated by using the similarity software of Traditional Chinese Medicine Fingerprinting (Chinese Pharmacopoeia Committee Version 2004 A). The similarity of the six profiles was 1.000, 0.997, 0.998, 0.995, 0.995, 1.000, respectively. The retention time and the peak area of the six peaks were recorded. The relative

Table 1: Source and similarity analysis results of *Musa basjoo* samples.

No.	Harvest place	Medicinal parts	Similarity
S1	Chongqing	Pseudostem	0.998
S2	Yuan Cun, Jinsha County, Guizhou Province	Pseudostem	0.998
S3	Jian he, Tianzhu County, Guizhou Province	Pseudostem	0.998
S4	Zunyi City, Guizhou Province	Pseudostem	0.998
S5	Qinglang (4), Tianzhu County, Guizhou Province	Pseudostem	0.998
S6	Guiyang Institute of traditional Chinese Medicine, Guiyang, Guizhou Province	Pseudostem	0.998
S7	Neijiang City, Sichuan Province	Pseudostem	0.998
S8	Chongqing (2)	Pseudostem	0.997
S9	Qinglang (1) , Tianzhu County, Guizhou Province	Pseudostem	0.998
S10	Qinglang (2) , Tianzhu County, Guizhou Province	Pseudostem	0.998
S11	Qinglang (3) , Tianzhu County, Guizhou Province	Pseudostem	0.998
S12	Sanjiang Farm, Guizhou Province	Pseudostem	0.997
S13	Sanjiang Farm (2) , Guizhou Province	Pseudostem	0.998
S14	Wan Zhai Xiang, Longli County, Guizhou Province	Pseudostem	0.998
S15	Sanjiang Farm, Guizhou Province	leaf	0.998
S16	Qinglang (2) , Tianzhu County, Guizhou Province	leaf	0.996
S17	Sanjiang Farm (2) , Guizhou Province	leaf	0.999
S18	Wan Zhai Xiang, Longli County, Guizhou Province	leaf	0.998
S19	Qinglang (1) , Tianzhu County, Guizhou Province	leaf	0.998
S20	Qinglang (3) , Tianzhu County, Guizhou Province	leaf	0.998
S21	Qinglang (2) , Tianzhu County, Guizhou Province	Rhizome	0.997
S22	Sanjiang Farm, Guizhou Province	Rhizome	0.999
S23	Sanjiang Farm (2) , Guizhou Province	Rhizome	0.998
S24	Wan Zhai Xiang, Longli County, Guizhou Province	Rhizome	0.999
S25	Qinglang (1) , Tianzhu County, Guizhou Province	Rhizome	0.998

retention time and the relative peak area of each common peak were calculated according to the reference of the 4th peak. The RSD of the relative retention time and the relative peak area were less than 3.0%. The result showed that the precision of the instrument is good.

Stability test

The sample solution was accurately absorbed from *Musa basjoo* (S1), and the samples were injected at 0, 3, 6, 9, 12 and 24 h, respectively. The test samples were determined by the method under the Instrument and chromatographic conditions. The similarity of the six profiles was 1.000, 1.000, 1.000, 1.000, 0.990, 1.000, respectively. The retention time and peak area of each common peak in the six profiles were recorded and 4th peak was selected as the reference peak. The RSD of relative peak area and relative retention time were less than 3.0%, which indicated that the sample solution is stable within 24 hours.

Repeatability test

Six samples of the pseudostem collected in Chongqing were prepared by the method of Preparation of samples" and determined according to the chromatographic conditions of Instrument and chromatographic conditions. The similarity of the six profiles was calculated by the similarity software of fingerprint of traditional Chinese medicine, the values were 0.998, 1.000, 0.989, 1.000, 1.000 and 1.000, respectively. The retention time and peak area of each common peak in the six profiles were recorded, and 4th peak was selected as the reference peak. The relative peak area and retention time of the common peaks were calculated. The RSD of the relative peak area and the relative retention time of the common peaks were less than 3.0 %, which indicated that the reproducibility of the method was good.

Establishment of UPLC fingerprint

A total of 25 *Musa basjoo* samples were used to prepare the sample solution according to preparation of samples, and the chromatographic conditions under Instrument and chromatographic conditions. It were used to detect and analyze by UPLC-ELSD chromatogram. The peak value, peak number and peak position of UPLC-ELSD chromatogram were compared and analyzed the fingerprint of the rhizome, pseudostem and leaf. The relative retention time and area of the common peak of *Musa basjoo* were calculated. The results are shown in fig. 2-6 and table 2, 3.

Fingerprint analysis

The chromatogram parameters of the pseudostems, the rhizomes and the leaf were compared. Using 4th peak (retention time 17.559 min) as the reference peak, 11 common peaks of the pseudostems were established and eight common peaks were identified among the three medicinal parts. In different parts of the same *Musa basjoo*, besides common peaks, there were more kinds of

Table 2: relative retention time of UPLC-ELSD fingerprints of *Musa basjoo*

Common peak	1	2	3	4	5	6	7	8	9	10	11
S1	0.138	0.814	0.899	1	1.026	1.545	2.516	2.556	2.612	2.653	2.686
S2	0.139	0.815	0.899	1	1.026	1.543	2.516	2.554	2.614	2.651	2.691
S3	0.138	0.815	0.896	1	1.028	1.545	2.512	2.583	2.615	2.654	2.683
S4	0.136	0.814	0.896	1	1.029	1.546	2.514	2.544	2.612	2.651	2.687
S5	0.139	0.817	0.898	1	1.025	1.541	2.513	2.542	2.618	2.657	2.687
S6	0.136	0.817	0.899	1	1.028	1.543	2.516	2.555	2.621	2.655	2.684
S7	0.141	0.816	0.899	1	1.028	1.538	2.515	2.555	2.617	2.646	2.682
S8	0.14	0.819	0.899	1	1.027	1.539	2.517	2.546	2.614	2.654	2.683
S9	0.139	0.815	0.897	1	1.027	1.539	2.512	2.548	2.614	2.655	2.691
S10	0.139	0.816	0.898	1	1.027	1.542	2.519	2.543	2.611	2.652	2.684
S11	0.138	0.819	0.898	1	1.028	1.541	2.514	2.555	2.616	2.653	2.683
S12	0.141	0.819	0.897	1	1.028	1.539	2.513	2.557	2.612	2.653	2.689
S13	0.149	0.818	0.899	1	1.028	1.539	2.519	2.549	2.614	2.657	2.687
:S14	0.14	0.817	0.897	1	1.028	1.541	2.511	2.546	2.616	2.643	2.684
S15	0.136	0.813	0.965	1	—	1.546	2.519	—	2.613	2.651	2.687
S16	0.136	0.815	0.901	1	—	1.541	2.513	—	2.618	2.657	2.687
S17	0.137	0.817	0.899	1	—	1.543	2.516	—	2.621	2.655	2.684
S18	0.136	0.814	0.899	1	—	1.538	2.515	—	2.617	2.646	2.682
S19	0.139	0.816	0.898	1	—	1.539	2.517	—	2.614	2.654	2.683
S20	0.136	0.817	0.897	1	—	—	2.526	—	2.619	2.656	2.684
S21	0.138	0.815	0.899	1	—	—	2.525	—	2.618	2.649	2.683
S22	0.139	0.82	0.898	1	—	—	2.527	—	2.615	2.659	2.683
S23	0.139	0.817	0.897	1	—	—	2.522	—	2.615	2.658	2.691
S24	0.138	0.816	0.899	1	—	—	2.529	—	2.617	2.653	2.682
S25	0.137	0.82	0.899	1	—	—	2.524	—	2.618	2.653	2.682

Note: "-" means not detected.

chemical constituents in the pseudostems than in the Rhizomes, and the relative peak areas of common peaks were close to each other, and the types of chemical components in the leaves were similar to those in the Rhizomes. However, the relative peak area of the common peaks was quite different from that of the common peaks.

Similarity analysis (SA)

The determination data of all samples were imported into the similarity calculation software of traditional Chinese medicine fingerprint. The peaks were selected, the matching templates were set, the peaks were matched automatically, and then the standard templates were set to evaluate the difference of spectrum peaks and the whole similarity. The UPLC-ELSD fingerprints of *Musa basjoo* showed that the similarity of the pseudostems was 0.997-0.998, that of the rhizomes and the pseudostems was 0.997-0.999, that of the Rhizomes and the leaf was 0.996-0.999, respectively. At the same time compared with the common model, *Musa basjoo* similarity results are shown in table 1.

Cluster analysis (CA)

The relative peak area values of 11 common peaks in UPLC-ELSD Chromatogram of the samples in the same plant were standardized to form 15 × 11 order original data matrix. The cluster analysis was carried out by SPSS 20.0 software, the intergroup connection method was used, and the Euclidean distance (Euclidean) was used as the measure of samples. According to the combination of correlation coefficients between the 15 samples, it could be divided into three groups. In the samples, S22 was clustered into I, S17, and S18 was clustered into II, and S9, S10, S12, S13, S14, S15, S19, S21, S23, S24, S25 were clustered into III. The results are shown in fig. 7.

Principal components analysis (PCA)

In order to evaluate and synthetically analyze the chemical similarity of *Musa basjoo* pseudostems, rhizome and leaf in different parts of the same plant, the relative peak areas of the samples were analyzed by principal component analysis (PCA) (Liang *et al*., 2018; Zhuang *et al*., 2018). The relative peak area of the sample was introduced into SIMCA 14.0 software, and three characteristic principal components (PC1, PC2, PC3) were obtained. The results are shown in fig. 8. According to the variance contribution rate, the cumulative explanatory power parameter R2X and predictive power parameter Q2 of the model were 0.92, 0.73, respectively. The results show that the model has a good degree of discrimination and prediction. Therefore, the first three principal component analyses could basically reflect the main characteristics of plant. Using principal component to establish coordinate system, the PCA score diagram, three dimensional score diagram and load diagram of the

Table 3: Relative peak area of UPLC-ELSD fingerprint of *Musa basjoo*

Common peak	1	2	3	4	5	6	7	8	9	10	11
S1	23.873	0.042	0.449	1	0.063	0.336	3.442	0.284	0.548	0.52	0.045
S2	32.358	0.046	0.422	1	0.089	0.331	4.603	0.291	0.816	0.764	0.038
S3	24.511	0.041	0.384	1	0.172	0.386	3.925	0.079	0.803	0.762	0.043
S4	72.667	0.195	1.231	1	0.291	0.186	4.688	0.036	1.789	2.283	0.069
S5	131.652	0.23	2.009	1	0.087	0.357	3.221	0.42	1.917	4.991	0.412
S6	23.632	0.04	0.41	1	0.103	0.411	3.562	0.106	0.61	0.66	0.042
S7	28.486	0.044	0.433	1	0.077	0.389	3.718	0.021	0.707	0.741	0.024
S8	15.732	0.048	0.556	1	0.971	0.1	1.108	0.143	0.739	1.429	0.034
S9	10.042	0.059	0.692	1	0.103	0.164	0.514	0.031	0.651	0.907	0.06
S10	25.01	0.048	0.427	1	0.102	0.403	3.3	0.025	0.63	0.85	0.093
S11	29.015	0.06	0.549	1	0.199	0.529	1.556	0.706	1.392	1.734	0.147
S12	25.303	0.141	0.449	1	0.253	0.258	0.765	0.356	0.608	1.024	0.078
S13	41.085	0.073	1.338	1	0.41	0.324	1.867	0.102	0.954	3.488	0.174
S14	15.732	0.048	0.556	1	0.971	0.1	1.108	0.143	0.739	1.429	0.033
S15	30.623	0.022	0.632	1	—	0.113	0.024	—	0.571	0.334	0.018
S16	71.174	0.116	0.975	1	—	0.19	0.23	—	0.693	2.978	0.127
S17	151.135	0.218	0.189	1	—	0.241	0.216	—	2.315	2.477	0.13
S18	111.835	0.384	1.674	1	—	0.56	2.312	—	12.847	21.103	0.623
S19	57.575	0.192	0.591	1	—	0.298	0.625	—	5.702	9.232	0.246
S20	35.899	0.168	0.279	1	—	—	0.184	—	0.565	0.66	0.065
S21	45.634	0.107	0.164	1	—	—	0.258	—	1.749	1.434	0.046
S22	532.059	0.445	1.859	1	—	—	8.743	—	4.858	24.569	0.763
S23	49.606	1.466	0.577	1	—	—	0.103	—	0.834	2.162	0.174
S24	31.556	0.023	0.345	1	—	—	0.949	—	1.03	1.43	0.021
S25	42.652	1.163	0.472	1	—	—	0.507	—	0.78	1.557	0.155

Note: "-" means not detected.

sample were obtained. Each point on the load graph represents a variable, and the farther away from the origin, the greater the contribution of the content of the component to the classification. The results are shown in figs. 9, 10 and 11. The results showed that there was a certain difference among the three of *Musa basjoo* in different parts of the plant. At the same time, there were some differences in the chemical composition of the three parts. According to the VIP value of the PLS-DA model, the main chemical components that lead to the differences were screened. The results are shown in fig. 12. It is generally believed that variables with VIP >1 play a key role in classification. It can be seen from fig. 12 that the VIP of 7^{th} peak, 9^{th} peak, 10^{th} peak and 2^{th} peak are all greater than 1value (VIP), so these peaks caused the biggest difference among the three parts. The results showed that the aggregation of the pseudostems and rhizome was concentrated and the difference was small. With the exception of a few samples S15, the other samples were basically clustered together. At the same time, combined with the common peak and the relative peak area, it indicated that the pseudostem has obvious difference from the rhizome and leaf in the chemical composition and quantity in the different parts of the same plant.

DISCUSSIONS

The main conditions of the following experiments were optimized: The extraction solvents of methanol, 50% methanol, ethanol and 50% ethanol were investigated. The results showed that the number of chromatographic peaks of methanol was more and the peak area was larger, so methanol was selected as extraction solvent. Two different extraction methods, ultrasonic and reflux, were studied. The results show that the reflux extraction efficiency is better than ultrasonic extraction. Therefore, reflux is the best extraction method in the experiment. The effects of different extraction time, such as 30min, 60 min, 90min, 120min, on the chromatogram were investigated. It shows that 90min information was complete, so 90min was chosen as the extracting time.

It showed that the effective components of lowering blood glucose in *Musa basjoo* Rhizomes may be total saponins and phenols (Qian *et al*., 2012). However, the common UV detectors, such as (UV) and DAD detector, cannot detect the saponins, steroids and triterpenes with weak UV absorption and lack of chromophore. The evaporative light scattering detector (ELSD) can detect both non-volatile compounds and compounds with or without UV absorption, which makes up for the deficiency of UV and

DAD detector. Therefore, this experiment uses ELSD detector to study the fingerprint of different parts of *Musa basjoo*.

The researcher carried out cluster analysis on the fingerprints of *Musa basjoo* Rhizomes in different producing areas and different harvesting periods (Xu *et al*., 2013). It was found that the Rhizome is affected greatly by the place of production and the harvest time. Considering that the other parts of the plant may also have this effect, so the method used in the experiment set a sample from different parts of the same plant. Therefore, the influence of growth environment, growth time and harvest time on medicinal materials was avoided.

Through similarity analysis, it was found that the similarity of *Musa basjoo* is between 0.984-0.999 and that of medicinal materials from different parts of the plant was between 0.996-0.999. The results showed that the rhizomes, pseudostems and leaves of the plant are very similar as a whole. But by comparing the common peak area and relative peak area, it was found that except for the three common components, pseudostems components had the most species, and the relative peak area was close to that of the rhizomes, and the relative peak area of the leaf was quite different from that of the Rhizomes. Cluster analysis showed that the pseudostems and the most of rhizomes were clustered together, indicating that the pseudostems and rhizomes are more similar. Through principal component analysis, it was also found that the relative peak area in the Rhizomes and pseudostems of *Musa basjoo*, which contributed the most to the components of the plant, was higher than that of other components. The results suggested that Rhizomes and pseudostems are more similar in chemical composition and quantity. In general, the chemical similarity between rhizomes and pseudostems was high.

CONCLUSION

The results suggested that the pseudostems could be used as a substitute for *Musa basjoo* rhizomes to avoid the waste of medicine resources. The previous research of the group shows that *Musa basjoo* rhizomes have anti-inflammatory and analgesic effects, so the pseudostems could be used as a substitute resource of the rhizomes in anti-inflammation and analgesia (Qian *et al*., 2012; Liang *et al*., 2017). But we'll continue to confirm pharmacological activities.

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