Acta Poloniae Pharmaceutica – Drug Research, Vol. 72 No. 6 pp. 1115–1123, 2015 ISSN 0001-6837
Polish Pharmaceutical Society

DEVELOPMENT OF A QUALITY CONTROL METHOD FOR SCHISANDRAE CHINENSIS FRUCTUS WITH MICELLAR ELECTROKINETIC CAPILLARY CHROMATOGRAPHY

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Abstract: The ripened fruits of *Schisandra chinensis* (Turcz.) Baill., called Schisandrae Chinensis Fructus, are commonly used in traditional herbal medicine with a long history. The lignan constituents, especially the dibenzocyclooctadiene-type lignans, are mostly responsible for the biological and pharmacological effects of this herbal medicine. In this paper, a new micellar electrokinetic capillary chromatography (MECC) method to analyze the active components of lignans is reported. The separating conditions for analysis of the lignans were optimized using a buffer solution consisting of 70 mM sodium dodecyl sulfate (SDS), 35% acetonitrile (v/v), and 100 mM Tris (pH 9.50). The applied voltage was 27 kV (positive polarity), and the capillary temperature was 25°C. Among the common peaks in the HPCE fingerprint, six peaks were identified as schizandrin, schizandrol B, schisantherin, deoxyschisandrin, γ-schisandrin and schizandrin C. Based on HPCE fingerprint and content determination, the quality of fifteen samples from different areas of China was objectively assessed. In summary, a new HPCE-based method was developed for the quality control of Schisandrae Chinensis Fructus, which could be very helpful for the proper use of Schisandrae Chinensis Fructus.

Keywords: Schisandrae Chinensis Fructus, micellar electrokinetic capillary chromatography, fingerprint, quality control

The ripened fruit of Schisandrae Chinensis Fructus has unique properties and has been widely used in China, Korea, Japan and other Asian countries to treat diseases and improve health. As reported previously, the ripened fruits of Schisandrae Chinensis Fructus mainly contain three classes of chemical constituents, namely lignans (1, 2),organic acid, and volatile oils. Schisandra lignans are the major constituents of Schisandrae Chinensis Fructus. More than forty have been isolated, among the most abundant are: schizandrin, schizandrol B, schisantherin, deoxyschisandrin, γ-schisandrin and schizandrin C. Lignans are largely responsible for the beneficial effect of schisandra extracts (3), which can prevent hepatic toxicity and virus infection, reduce oxygen radical generation, inhibit inflammation and so on (4-7).

So far, many approaches have recently been developed for the qualitative and quantitative analysis of the major lignans in Schisandrae Chinensis Fructus. Among these, the reversed-phase high performance liquid chromatography (RP-HPLC) with UV detection and thin-layer chromatography methods are most frequently used (8). Nevertheless, those methods are time consuming and require excessive solvent.

In past years, great advance has been made in capillary electrophoresis (CE). Due to rapid analytical speed, high resolution and low-loss of solvent, this method has been widely used in the analysis of proteins and peptides (9-12). Presently, this analytical method has a tendency of being used in the quality assessment of drugs, especially for traditional herbs, because there are many uncharged ingredients in traditional herbs and the uncharged molecules can be analyzed by micellar electrokinetic capillary chromatography (MECC). Unfortunately, the quality control of Schisandrae Chinensis Fructus by CE has not been well investigated yet.

To address these deficiencies, a high separation-capable MECC method was generated for the separation of lignans in this study. Further, in order

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to comprehensively evaluate the quality of Schisandrae Chinensis Fructus, fingerprints were established based on the chromatography from 15 sample batches collected from northern China, and the contents of six lignans in the herb were simultaneously determined by MECC method as well.

EXPERIMENTAL

Chemical and reagents

The major lignans including schizandrin, schizandrol B, schisantherin, deoxyschisandrin, γ-schisandrin and schizandrin C (Fig. 1) were isolated from Schisandrae Chinensis Fructus as described elsewhere (13, 14). The chemical structures of these compounds were characterized by several methods, including UV, IR, NMR and MS. The purity of the compounds, as determined by HPLC, was > 98%. Analysis-grade sodium dodecyl sulfate (SDS) and tris(hydroxymethyl)aminomethane (TRIS) were purchased from Sigma company (St. Louis, MO, USA), HPLC-grade acetonitrile was purchased from Tedia (Fairfield, USA) and high-purity deionized water (18.2 MΩ cm) was obtained from a Millipore system (Millipore, Bedford, MA, USA). Analysis-grade methanol used for sample extraction, sodium hydroxide (NaOH) and hydrochloric acid (HCl) were purchased from Shanghai Chemical Corporation of China.

Plant material

The samples (S1 - S15) of Schisandrae Chinensis Fructus were collected from Heilongjiang, Liaoning and Jilin province of China during early autumn and identified by professor Lu Tuling of Nanjing University of Chinese Medicine. Voucher specimens were deposited at College of Pharmacy of Nanjing University of Chinese Medicine. Details of the samples are listed in Table 1.

CE equipment and conditions

MECC analysis was performed with Agilent series G1600 AX equipment consisting of automatic injector, temperature controller, and diode array detector (DAD). Data analysis was performed by means of the CE ChemStation software. Fused-silica capillaries (Agilent Company, USA) of 75 μm ID, 64.5 cm total length and 56.0 cm effective length were used for MECC analysis. Injection was accomplished by the application of 50 mbar for 4 s. The background electrolyte solution was prepared by 40 mM SDS and 35% acetonitrile in 100 mM Tris buffer, then, the pH of the solution was adjusted to 9.5 with 0.2 M HCl to make up the running electrolyte. Separation were performed at 27 kV (positive polarity) and 25°C column temperature. Samples were detected by DAD at 250 nm. To ensure good reproducibility, the capillaries were washed by 0.1

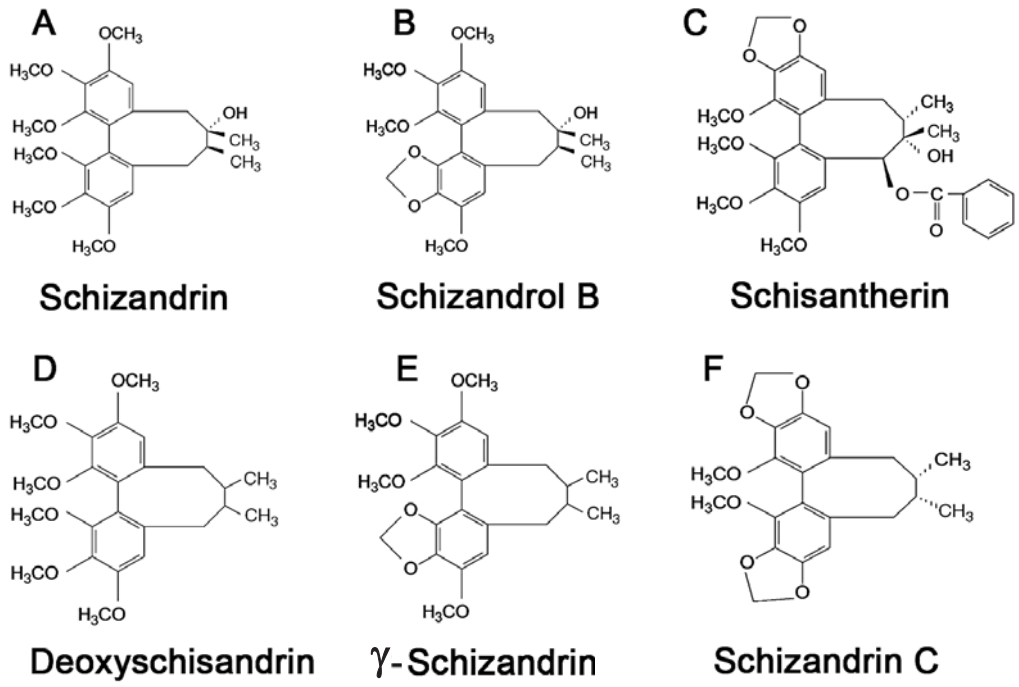

Figure. 1. Chemical structures of the standard compounds in Schisandrae Chinensis Fructus

Table 1. Details of the herbal materials collected.

No.	Producing area	Species	Collection data
1	Xinglin, Heilongjiang	*Fructus Schisandrae Chinensis*	23. 10. 2012
2	Qiqihaer, Heilongjiang	*Fructus Schisandrae Chinensis*	01. 11. 2012
3	Yichun, Heilongjiang	*Fructus Schisandrae Chinensis*	11. 11. 2012
4	Xinganlin, Heilongjiang	*Fructus Schisandrae Chinensis*	13. 10. 2013
5	Mudanjiang, Heilongjiang	*Fructus schisandrae Chinensis*	26. 10. 2013
6	Teli, Heilongjiang	*Fructus Schisandrae Chinensis*	05. 11. 2013
7	Mishan, Heilongjiang	*Fructus schisandrae Chinensis*	09. 11. 2013
8	Qingan, Heilongjiang	*Fructus Schisandrae Chinensis*	16. 11. 2013
9	Zhaoqing, Heilongjiang	*Fructus Schisandrae Chinensis*	23. 11. 2013
10	Jian, Niaoning	*Fructus Schisandrae Chinensis*	25. 11. 2013
11	Kuandian, Niaoning	*Fructus Schisandrae Chinensis*	26. 11. 2012
12	Wusong, Changbaishan, Jilin	*Fructus Schisandrae Chinensis*	05. 11. 2012
13	Chibei, Changbaishan, Jilin	*Fructus Schisandrae Chinensis*	06. 11. 2013
14	Songjianghe, Jilin	*Fructus Schisandrae Chinensis*	23. 11. 2013
15	Wangqin, Jilin	*Fructus Schisandrae Chinensis*	28. 11. 2013

M NaOH for 3 min, deionized water for 5 min, then running electrolyte for 5 min.

Standard preparation

Stock solutions of each lignan were prepared by dissolving the precisely weighed standards into 10 mL methanol, then, portions of the six solutions were combined, evaporated to dryness, and the residue was dissolved in 2 mL background buffer solution (40 mM SDS and 35% acetonitrile in 100 mM Tris buffer). Concentrations of the six compounds in the background buffer solution were 113 μg/mL for schizandrin, 87.5 μg/mL for schizandrol B, 93.75 μg/mL for schisantherin, 85.75 μg/mL for deoxyschisandrin, 95.0 μg/mL for γ-schisandrin and 57 μg/mL for schizandrin C.

Sample preparation

The dried Schisandrae Chinensis Fructus were pulverized and sieved (60 mesh). Samples (0.2 g) were extracted with methanol (50 mL) for 30 min by ultrasonication (250 W, 30 kHz) and the extraction was repeated twice. Extracts were combined, filtered, evaporated to dryness, and the residue was dissolved in 2 mL of background buffer solution (40 mM SDS and 35% acetonitrile in 100 mM Tris buffer). Solutions were filtered through a 0.22 μm polytetrafluoroethylene membrane filter before analysis.

Data analysis

Similarity analysis was performed by use of the professional software "Similarity Evaluation System (SES) for Chromatographic Fingerprint of Traditional Chinese Medicine (Version 2004A)" recommended by Chinese Pharmacopoeia Commission. This software is currently not commercially available, but the Chinese Pharmacopoeia Commission allows free use of this software, solely for quality control of Chinese herbal medicine. The principle of the software is to evaluate the similarity of different chromatograms by calculating the correlation coefficient and/or multivariate cosine.

RP-HPLC analysis

HPLC analysis was performed with Agilent series 1100 equipment consisting of G1311A quaternary pump, G1315B-DAD, and G1316A column compartment. Samples were separated on a Kromasil (Sweden) C_{18} column (4.6 mm i.d. × 250 mm, 5 μm particle). The mobile phase was a gradient prepared from H_2O (component A) and CH_3CN (component B), and the conditions used for gradient elution were: 0–15 min, 2–55% CH_3CN; 15–30 min, 55–60% CH_3CN; 30–50 min, 60–70% CH_3CN; 50–60 min, 70–100% CH_3CN; 60–70 min, 100% CH_3CN. The flow rate was 1.0 mL/ min. After the 100% acetonitrile, the mobile phase was switched to 2% acetonitrile for 10 min to equilibrate the column before the next sample was injected. The injection volume was 10 μL. Chromatograms with good separation were obtained when the column temperature was 30°C. The detection wavelength was 250 nm (15).

RESULTS AND DISCUSSION

Optimization of the extraction conditions

To achieve maximum recovery of the components in Schisandrae Chinensis Fructus, the extraction conditions, including solvent and method, were optimized. First, petroleum ether, n-hexane, ethanol, methanol, 95% ethanol, 75% ethanol, 95% methanol and 75% methanol were evaluated as extracted solvents. Methanol was shown to be the best solvent, because it enabled maximum extraction of the most active components with relatively high yield. To examine the effect of extraction method on recovery, ultrasonic extraction, Soxhlet extraction and extraction under reflux were investigated. Although similar recovery was achieved by use of all three methods, ultrasonic extraction was selected mainly because of its relatively simple handling procedure. The samples were eventually extracted twice with 30 min for each time.

Notably, the capillaries were usually blocked if the sample extraction solution was directly injected. This problem can be circumvented by evaporating the extracts to dryness and dissolving the residue in 2 mL of background buffer solution.

Optimization of the MECC separation conditions

The β-CD is a frequently used substance in MECC separation, because its special structure allows the formation of inclusion compounds that consists of β-CD and the analytes (16, 17). In the experiments, when the β-CD of different concentrations (5, 10, 15, 20, 25, 30 mmol/L) were added to tetraborate systems, the separation of the main lignans did not improve noticeably, and meanwhile, many air bubbles were produced in the β-CD system. Therefore, β-CD is not suitable for the analysis.

Besides β-CD, SDS surfactants are also widely used in MECC (18, 19). Both SDS-tetraborate and SDS-Tris systems were used in analyses. While SDS-tetraborate was advantageous in the analysis of small molecular organic compounds, SDS-Tris was preferentially used in protein analysis. The results shown that the SDS-Tris system was better employed in analyzing the lignans of Schisandrae Chinensis Fructus by MECC, as compared with the SDS-tetraborate system, because a good separation of the lignans was achieved under SDS-Tris system.

In order to optimize SDS concentration, effect of SDS at concentrations ranging from 10 to 80 mmol/L on lignan separation was investigated. The results demonstrated that the lignans could not be nicely separated in the presence of < 30 mmol/L SDS. However, if SDS was used at high concentrations, Joule heat was high, and further, more bubbles were produced. In addition, SDS at high concentrations led to prolonged migration time for the analytes and peak broadening. As such, the optimal concentration for SDS in the analysis of lignans was finally set at 40 mmol/L.

The influence of TRIS concentration on lignan separation was further explored. In this experiment, TRIS concentration varied from 10 to 150 mmol/L. The results demonstrated that the resolution of peaks was increasingly improved as the relative concentration of TRIS in the buffer system increased, and the optimal concentration for TRIS was finally set at 100 mmol/L.

Because of the lipophilicity of the lignans, suitable amounts of organic modifiers which can promote the dissolution of the lipophilic compounds were added to the background buffer. In this study, methanol and acetonitrile were used as organic modifiers and their effects on peaks resolution were examined. The results demonstrated that the migration behavior of acetonitrile was better than that of methanol. The effect of acetonitrile at different concentrations was further examined. The result revealed that 35% of acetonitrile was found to provide the best separation.

Table 2. Linearity calibration curves of the determined components.

No.	Identification	Regression equation	R (n = 6)	Linear ranges (μg/mL)	LOD (μg/mL)	LOQ (μg/mL)
1	Schizandrin	y = 6.982x + 28.994	0.9992	11.3-45.20	0.45	0.13
2	Schizandrol B	y = 5.733 x + 19.112	0.9992	8.75-35.00	0.44	0.13
3	Schisantherin	y = 3.655 x + 11.221	0.9995	4.69-18.75	0.47	0.14
4	Deoxyschisandrin	y = 4.224 x + 18.702	0.9995	8.58-34.30	0.43	0.13
5	γ-Schisandrin	y = 6.229 x + 10.002	0.9991	9.50-38.00	0.48	0.14
6	Schizandrin C	y = 5.429 x + 18.868	0.9992	2.85-11.40	0.29	0.09

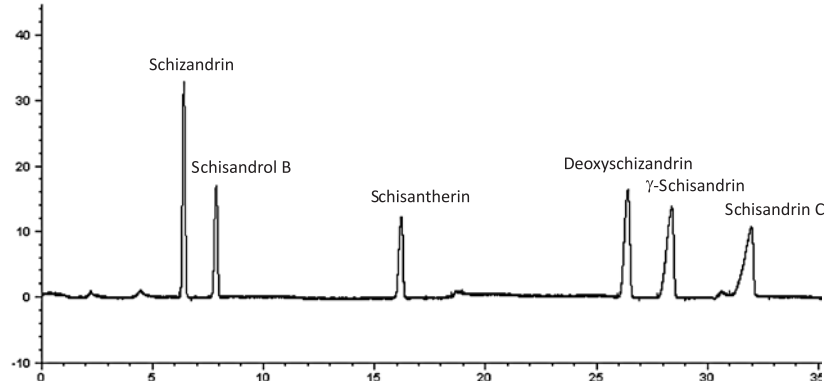

Figure 2. Chromatograms obtained from the standard compounds. The compounds corresponding to peaks are schizandrin, schisandrol B, schisantherin, deoxyschizandrin, γ-schisandrin and schisandrin C, respectively

Table 3a. Precision, repeatability and recovery data of six lignan compounds by the proposed HPCE method.

Compound	Precision				Reproducibility		Stability		Accuracy	
	Intra-day		Inter-day							
	Mean (%)	RSD (%)	Mean (%)	RSD (%)	Mean (%)	RSD (%)	Mean (%)	RSD (%)	Mean (%)	RSD (%)
Schizandrin	0.422	1.666	0.423	2.723	0.420	3.646	0.419	2.646	101.32	3.22
Schizandrol B	0.083	1.822	0.082	2.833	0.082	3.994	0.081	2.867	98.23	3.76
Schisantherin	0.024	2.036	0.023	1.996	0.023	3.877	0.023	3.456	97.54	3.08
Deoxyschisandrin	0.094	2.432	0.094	2.655	0.095	3.664	0.094	3.273	101.32	3.01
γ-Schisandrin	0.212	2.177	0.212	2.277	0.213	2.245	0.213	3.163	101.37	3.54
Schizandrin C	0.017	2.321	0.018	2.435	0.018	3.082	0.018	3.002	102.33	3.45

Mean (%): the average percentage content of the compound. Recovery (%) = (amount found – original amount)/ amount spiked × 100%

Table 3b. Precision, repeatability and stability data of fingerprint by the proposed HPCE method.

Similarity value	Precision				Reproducibility		Stability	
	Intra-day		Inter-day					
	Mean	RSD (%)	Mean	RSD (%)	Mean	RSD (%)	Mean	RSD (%)
	0.999	0.687	0.999	0.929	0.996	1.203	0.998	1.106

Mean: the average similar value of the samples.

The pH value is also an important parameter for lignans separation. In this study, the effect of pH value ranging from 9.0 to 10.0 was examined. The results showed that the peaks resolution was getting better as the pH values increased from 9.1 to 9.5. However, when the pH value was above 9.5, the resolution decreased, probably because high pH value led to heat overproduction. Therefore, the optimal pH value was 9.5.

The effects of voltages ranging from 18 kV to 28 kV on peaks resolution in MECC analysis were also examined. The results revealed that the optimal voltage was 27 kV because it gave the best peak resolution and the shortest analytical time.

Calibration and validation

Six concentrations of the standard solutions were analyzed in triplicate, and calibration curves were constructed from peak areas of standards *versus* their concentrations. The standard solutions were diluted to a series of appropriate concentrations with acetonitrile. The limits of determinations

(LODs) (S/N ≈ 3) and limits of quantifications (LOQs) (S/N ≈ 10) under the present conditions were determined. The calibration data, linear ranges, R, LOD, and LOQ values are listed in Table 2. The data showed that there was a good relationship between the concentrations of the six compounds measured and their peak areas within the test range (R > 0.999).

The optimized conditions were subjected to method validation. The intra-day and inter-day precisions of the content determination method were evaluated by analysis of the standard solution during a single day or three consecutive days, respectively. The reproducibility of the content determination method was evaluated by analysis of six replicates of the same sample. The same sample solution was also analyzed nine times consecutively at different times after preparation (0, 4, 8, 12, 16, 20, 24, 28, and 32 h) to test its stability. Accuracy of content determination was determined in recovery experiments in which the standard compounds of 80, 100 and 120% of the sample content were added to approximately 0.1 g of sample (S1) and then extracted and analyzed. Data analysis of the chromatograms was performed for six main lignan components as shown in Table 3a. Data analysis of the chromatographic fingerprints was performed by use of SES software, and similarities between chromatograms were used to evaluate fingerprint quality, which determines the total quality of the drug. The results from this analysis are listed in Table 3b. According to the result of the test, the analytical method was effective for simultaneous determination of the six compounds with fingerprint evaluation in Schisandrae Chinensis Fructus.

RESULTS

Under the optimized MECC conditions, a mixture of the standard lignans, including schizandrin, schizandrol B, schisantherin, deoxyschisandrin, γ-schisandrin, and schizandrin C were separated, as shown in Figure 2. Further, fifteen batches of Schisandrae Chinensis Fructus samples collected from different producing areas in China were also analyzed by MECC.

Determination of lignan content in the herbs

The contents of six compounds of the fifteen batch samples were determined using optimized MECC conditions, and are listed in Table 4. Chromatograms obtained from fifteen samples from different producing areas were overlaid in Figure 3. In these analytes, schizandrin was the most abun-

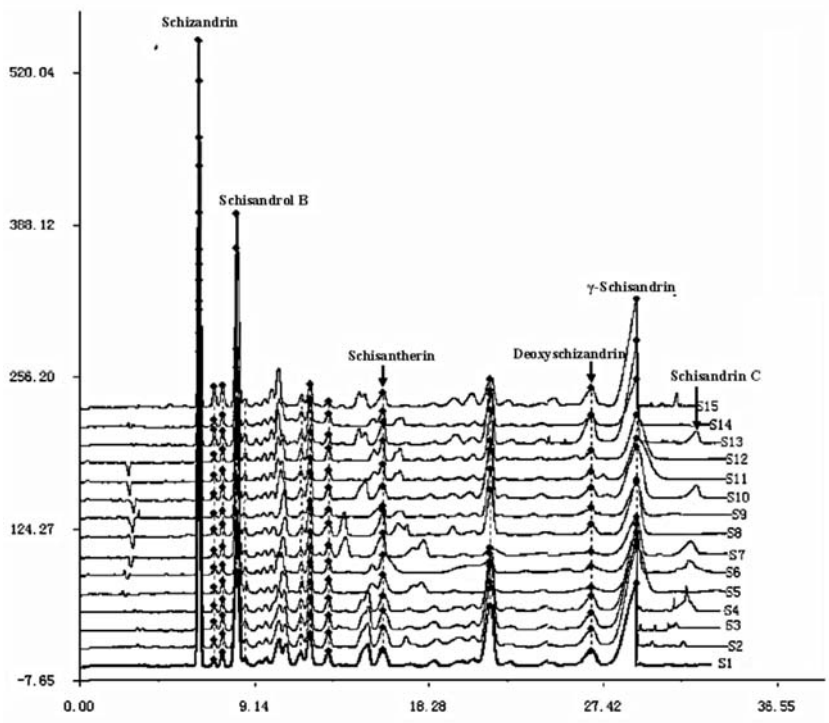

Figure 3. Overlaid chromatograms obtained from 15 samples from different locations. Samples 1-9 were from Heilongjiang province, Samples 10, 11 were from Niaoning province, samples 12-15 were from Jilin province

Table 4. The content of six main lignnans compounds from 15 samples (n = 3).

No.	The percentage content of six main lignans compounds (%)						
	Schizandrin	Schizandrol B	Schisantherin	Deoxyschisandrin	γ-Schisandrin	Schizandrin C	Total lignans
S1	0.513 ± 0.005	0.101 ± 0.002	0.034 ± 0.0010	0.109 ± 0.002	0.325 ± 0.002	ND	1.082 ± 0.02
S2	0.403 ± 0.004	0.099 ± 0.002	0.034 ± 0.0009	0.198 ± 0.002	0.301 ± 0.002	0.028 ± 0.0008	1.064 ± 0.02
S3	0.477 ± 0.006	0.111 ± 0.001	0.024 ± 0.0005	0.149 ± 0.001	0.214 ± 0.003	ND	0.975 ± 0.01
S4	0.415 ± 0.006	0.089 ± 0.001	0.032 ± 0.0008	0.192 ± 0.002	0.118 ± 0.002	ND	0.847 ± 0.01
S5	0.545 ± 0.004	0.123 ± 0.003	0.030 ± 0.0008	0.094 ± 0.001	0.226 ± 0.001	ND	1.018 ± 0.02
S6	0.412 ± 0.005	0.080 ± 0.002	0.019 ± 0.0004	0.135 ± 0.002	0.338 ± 0.002	0.023 ± 0.0006	1.007 ± 0.01
S7	0.428 ± 0.004	0.119 ± 0.002	0.024 ± 0.0005	0.094 ± 0.001	0.214 ± 0.002	0.013 ± 0.0003	0.892 ± 0.01
S8	0.578 ± 0.006	0.211 ± 0.005	0.013 ± 0.0003	0.198 ± 0.002	0.308 ± 0.002	ND	1.308 ± 0.02
S9	0.534 ± 0.007	0.208 ± 0.004	0.016 ± 0.0003	0.138 ± 0.001	0.324±0.003	ND	1.220 ± 0.02
S10	0.468 ± 0.005	0.123 ± 0.003	0.034 ± 0.0008	0.109 ± 0.002	0.198 ± 0.002	0.024 ± 0.0005	0.956 ± 0.01
S11	0.459 ± 0.004	0.134 ± 0.001	0.024 ± 0.0009	0.108 ± 0.002	0.255 ± 0.003	ND	0.980 ± 0.02
S12	0.498 ± 0.003	0.102 ± 0.002	0.046 ± 0.0011	0.219 ± 0.001	0.286 ± 0.002	ND	1.151 ± 0.02
S13	0.474 ± 0.003	0.168 ± 0.002	0.043 ± 0.0014	0.123 ± 0.001	0.389 ± 0.003	0.019 ± 0.0004	1.216 ± 0.01
S14	0.458 ± 0.006	0.099 ± 0.001	0.020 ± 0.0004	0.099 ± 0.001	0.351 ± 0.002	ND	1.027 ± 0.02
S15	0.518 ± 0.004	0.145 ± 0.001	0.024 ± 0.0003	0.103 ± 0.002	0.228 ± 0.002	ND	1.019 ± 0.02

Total lignans: the sum of 6 average contents of lignans (Schizandrin, Schizandrol B, Schisantherin, Deoxyschisandrin, γ-Schisandrin and Schizandrin C). ND: not detected.

Table 5. Similarity values of 15 samples from different areas.

No.	Similarity value	No.	Similarity value
S1	0.928	S9	0.918
S2	0.919	S10	0.901
S3	0.902	S11	0.943
S4	0.912	S12	0.952
S5	0.992	S13	0.927
S6	0.994	S14	0.943
S7	0.936	S15	0.942
S8	0.924		

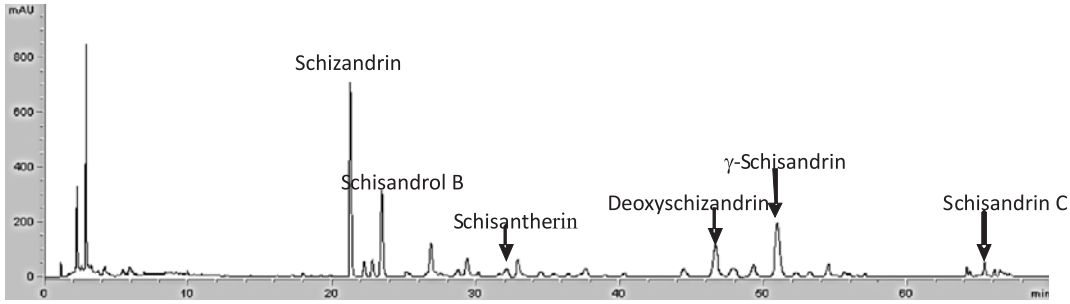

Figure 4. HPLC chromatogram of the extraction with optimized conditions. Samples were separated on a Kromasil (Sweden) C_{18} column (4.6 mm i.d. × 250 mm, 5 μm particles). The mobile phase was a gradient prepared from H_2O (component A) and CH_3CN (component B) and the conditions used for gradient elution were: 0–15 min, 2–55% CH_3CN; 15–30 min, 55–60% CH_3CN; 30–50 min, 60–70% CH_3CN; 50–60 min, 70–100% CH_3CN; 60–70 min, 100% CH_3CN. The flow rate was 1.0 mL/min. After the 100% acetonitrile, the mobile phase was switched to 2% acetonitrile for 10 min to equilibrate the column, then the next sample was injected. The injection volume was 10 μL. Chromatograms with good separation were obtained when the column temperature was 30°C. The detection wavelength was 250 nm

dant constituent in all of the samples, with a content that varied from 0.403 to 0.518% and occupied 37.9 to 53.5% of the total lignan contents. The γ-schisandrin ranked as the second main constituent with content that varied from 0.118 to 0.389%, followed by deoxyschisandrin, schizandrol B, and schisantherin. Schizandrin C was the compound with the least content, which could not be detected in ten samples including six batches from Heihongjiang (S1, S3, S4, S5, S8, S9), one batch from Liaoning (S11), and three batches from Jilin (S12, S14, S15).

Fingerprints of the lignans in the plants

In the study, the common pattern of HPCE fingerprints was established by using SES software. More than twenty peaks were separated in all sample batches, but only twelve peaks could be regarded as common peaks, of which RSD of the peaks' relative retention times for all batches was less than 1%, and the peaks belonged to the same substance. The overlaid chromatographs, as shown in Figure 3, provided a general profile of the compounds in these samples.

Among these peaks, schizandrin, schizandrol B, schisantherin, deoxyschisandrin, γ-schisandrin, and schizandrin C were identified by comparing the migration times and UV spectra of peaks with the six standards, respectively. Furthermore, spiking samples with the standards further supported the identification of the lignan peak. Peak of schizandrin C did not belong to the common peaks, because it could not be detected in ten batches of samples. As a result, the similarity value for the fifteen batches of samples was above 0.99 (Table 5).

RP-HPLC analysis

The sample extract could be separated by HPLC under the optimized HPLC conditions, as

listed in section 2.7, but the analytical time for sample was 70 min, which was longer than the one from HPCE analysis. The chromatogram of sample 2 from Heilongjiang obtained with the optimized conditions is shown in Figure 4. As compared with RP-HPLC, HPCE shortened the analytical time and reduced the reagents consumption, which is more advantageous for herb ingredient analysis.

CONCLUSION

In this work, a MECC-based method was developed for the analysis of lignans from Schisandrae Chinensis Fructus. As compared with HPLC, this proposed method is simple and has characteristics of high separation efficiency, rapid analytical time, and low cost. With the optimal separation conditions, fingerprint and the content determination were successfully performed for evaluating the quality of Schisandrae Chinensis Fructus. Thus, this method can be adopted for the quality control of lignans of Schisandrae Chinensis Fructus.

Acknowledgments

We appreciate Key projects of Natural Science Foundation of Jiangsu Province for university (13KJA360003); the financial supports from National Natural Science Foundation (No. 30701108, 31071250, 81473293); preliminary research foundation of Nanjing University of Chinese Medicine (No. 12XYY06); the specific research program for the industry of Chinese medicine (201307008).

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Received: 21. 10. 2014