The Overall Quality Control of *Radix Scutellariae* by Capillary Electrophoresis Fingerprint

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Abstract

The qualitative and quantitative analyses are developed for the overall quality control of *Radix Scutellariae*, a Chinese herb, by capillary electrophoresis fingerprint (CEFP). All experiments are carried out in an uncoated fused silica capillary (75 cm × 75-µm i.d., effective length 63 cm) with a 50 mmol/L sodium borate solution (containing 5% acetonitrile, pH 9.30) under 12 kV. The detection wavelength is set at 280 nm, and naproxen is selected as the referential peak. Some parameters are used to evaluate the similarities of CEFPs. Eight co-eluting peaks are selected as the fingerprint peaks of *Radix Scutellariae*. The similarities between each of the ten samples and the referential CEFP of *Radix Scutellariae* are evaluated both qualitatively and quantitatively. Determination results indicate that the baicalin contents from different locations are varied. The methods of CEFP and quantitative analysis are rapid, simple, and accurate, with good repeatability, and can be used for the quality control of *Radix Scutellariae*.

Introduction

Radix Scutellariae, the dried root of *Scutellaria baicalensis Georgi*, is a commonly used herbal medicine in China. Its uses include anti-inflammation, anti-cancer, treating fevers, stopping bleeding, preventing miscarriages, decreasing blood pressure, and treating gastrointestinal diseases (1). Baicalin is the most abundant component, which has anti-inflammatory (2), anti-HIV (3), anti-tumor (4), and anti-oxidation effects (5). Its structure is shown in Figure 1. Traditionally, the contents of baicalin in *Radix Scutellariae* have been used to evaluate the plant's quality. However, the safety and efficacy of herbal medicines are not just attributed to a particular compound, because it is well known that an herbal medicine is a complex mixture containing dozens, even hundreds, of chemical components that are usually responsible for its therapeutic effects. Therefore, the quality control of herbal medicines, unlike that of western medicines, is beyond the ability of routine analysis, which only focuses on a single or a few marker components.

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Chromatographic fingerprinting places more emphasis on the systemic characteristics of composition of the complex chemical constituents, and provides a more logical technique for the quality control of herbal medicines. Nowadays, in the modernization of traditional Chinese medicine, this technique is widely applied, especially in its prescribed injection (6), and it has also been suggested by the World Health Organization as a way to check the authenticity or quality evaluation of herbal medicines (7). In recent years, high-performance capillary electrophoresis (HPCE) has become increasingly recognized as an important separation technique, due to its high resolution, small sample volume, extraordinary small solvent consumption, and rapid separation with high efficiency. Recently, several studies have been reported on chromatographic fingerprinting using CE (8,9). In the present study, HPCE was used to establish the fingerprint of *Radix Scutellariae* and determine the baicalin content, and the procedure was simple, quick, and has a good repeatability. The objective is to offer a new method that can be used for the overall quality control of *Radix Scutellariae*.

Experimental

Reagents and standards

Sodium borate (analytical reagent grade) was supplied by the Reagent Department of Zhengxin Technological Institute (Shenyang, China). Methanol and acetonitrile (HPLC grade) were supplied by Yuwang Industry Co. Ltd (Shandong, China). Boracic acid, sodium dodecyl sulfate (SDS), NaH_2PO_4, Na_2HPO_4, β-CD, and all other chemicals were of analytical reagent grade. Water used for extraction and buffer solution was deionized. Ten batches of drug samples of *Radix Scutellariae*, identified by the authors, were obtained from ten different places as follows: S1 (Longxi County); S2 (Tongchuan County); S3 (Chenggu County); S4 (Tunliu County); S5 (Yanqing County); S6 (Shangzhou district); S7 (Zhalute Banner); S8 (Nanmeng Township); S9 (Lufeng County); and S10 (Pingyu County). Naproxen (structure shown in Figure 1) was supplied by Chifeng Pharmaceutical Group, (Chifeng, Inner Mongolia, China). Baicalin was purchased from the National Institute for Pharmaceutical and Biological Products (Beijing, China).

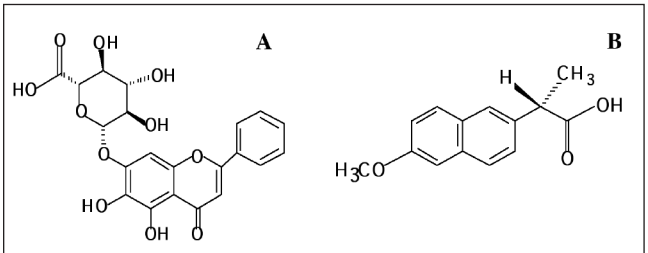

Figure 1. The molecular structures of baicalin (A) and naproxen (B).

Instrumentation

All analyses were performed on a CHY-3000 HPCE instrument, composed of a hydrodynamic injector (Chenyang Biotechnology Co. Ltd, Shenyang, China). Chromatographic data were recorded by a Johnson Chromato-Station (Johnson Technologies, Dalian, China). An ultrasonic bath of KS-1200 was purchased from Xinzhou Technology Co., Ltd (Tianjin, China). A rotary evaporator of RE-52 was supplied by the Yarong Biochemistry Instrument Co., Ltd (Shanghai, China). A laboratory electronic balance of BS110S was purchased from Sartorius (Goettingen, Germany). A fused-silica capillary tube was supplied by the Yongnian Optical Fiber Factory, (Hebei, China). A pHs-3 DC pH meter was purchased from Shanghai Huxin Heat Exchanging Equipment (Shanghai, China).

Electrophoresis conditions

An uncoated fused-silica capillary tube (75 cm × 75 µm i.d.) was used, and the detection window was set at 63 cm from the injection. The background electrolyte was 50 mmol/L sodium borate solution (containing 5% acetonitrile), and its pH was adjusted to 9.30 with 1 mol/L NaOH. For all detections performed at 280 nm, the voltage was maintained at 12.0 kV. The samples were introduced into the capillary by hydrostatic injection (10 cm high) time for 15 s. Naproxen was used as the referential peak. All of the samples were filtered through a 0.45-µm membrane filter before the assay. Daily conditioning of the capillary was done by washing for 5 min with the background electrolyte (BGE), then running for 5 min with the BGE. Between the runs, the capillary was purged for 5 min with BGE. The running buffer was refreshed after every 10 runs to ensure the good repeatability. After one day's experiment, the capillary was purged for 10 min with 0.1 mol/L NaOH and then 10 min with deionized water.

Preparation of the standard solution

A 36.0-mg portion of baicalin was accurately weighed, and methanol was added to make 10 mL exactly, after shaking, to serve as the standard solution.

Preparation of the referential peak solution

A 51.0-mg portion of naproxen was accurately weighed, and 25% (v/v) acetonitrile was added to make 10 mL exactly, after shaking, to serve as the referential peak solution.

Preparation of the sample solutions

The crude drug of *Radix Scutellariae* was dried at 60°C for 40 min. After being minced, 2.50 g powdered drug was accurately weighed and extracted twice under reflux for 2 h each time with 50 mL and 40 mL water, respectively. The combined filtrates were evaporated to 20 mL under reduced pressure, precipitated by ethanol solution (80%, v/v) for 24 h, and then filtered. Thereafter, the ethanol solvent was removed in a rotary evaporator to 15 mL, and sodium borate solution (50 mmol/L) was added to make exactly 25 mL and shaken. Finally, the solution of 1.0 mL and the internal solution of 1.0 mL were taken and accurately diluted to 10 mL by water after shaking to serve as the sample solution, which was stored at 5°C in a refrigerator before the test.

Results and Discussion

Optimization of analyses conditions

Selection of the extracting solvents

Baicalin should be extracted by methanol, ethanol, or a water solution due to its polarity. Different methods have been reported in the literature for the preparation of the sample solution for *Radix Scutellariae* (10). More peaks were obtained by water extraction and precipitation with alcohol, in which the peak shape of baicalin was desirable. This method had advantages such as high extraction efficiency, low consumption, and less pollution. Therefore, water was chosen as the extracting solvent. The influences of different volumes and extraction times were also investigated, and the preparations of the sample solution were selected as previously described.

Selection of the CE conditions

Guoxiang (11) proposed using a chromatographic fingerprint, *F*, to evaluate the fingerprints from the following three aspects: first, the effective separation rate (β) as described in equation 1 to indicate the separation efficacy, where m is the pairs of baseline-separated peaks, and n indicates the total number of common peaks; second, the leveling coefficients of common peaks signals (γ) as described in equation 2 to disclose the uniformity of fingerprint signals, where x_i represents the ith common peak area; and last, the product of all common peak areas to disclose the magnitude of all signals. Therefore, chromatographic fingerprint F was defined in equation 3 to comprehensively reflect how a fingerprint is better, where A_0 represents

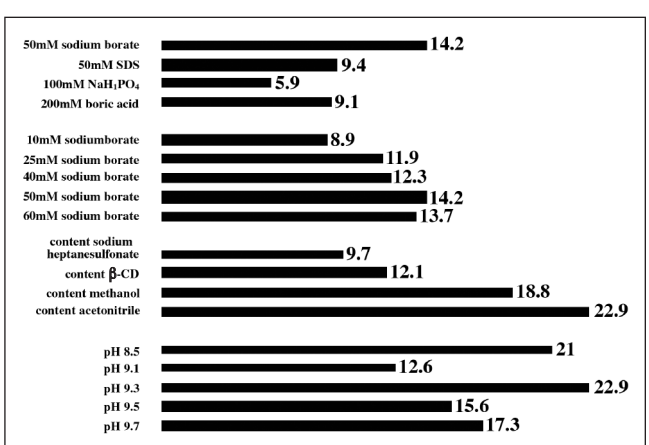

Figure 2. F values under different conditions.

the average geometry peak area. The higher the *F* value, the better the condition applied. In the present paper, the *F* values under different conditions were calculated in order to obtain the better CE condition (see Figure 2).

$$\beta = \frac{m}{n-1} \quad \text{Eq. 1}$$

$$\gamma = \frac{\sum_{i=1}^{n} X_i}{\sqrt{n\sum_{i=1}^{n} X_i^2}} \quad \text{Eq. 2}$$

$$F = \lg R = n\beta\gamma \lg A_0 = \beta\gamma \sum_{i=1}^{n} \lg x_i \quad \text{Eq. 3}$$

Effect of the BGE

Phosphate solution, SDS, and sodium borate solutions of different concentrations were tested as the BGE, respectively, and the results showed that using a borate solution as the BGE was much better. As the boron atom is not saturated with electrons, sodium borate is apt to interact with chemicals in herbs, producing complex compounds, which results in good separation. The concentration of the BGE solution not only affected the zeta electric potential of the internal surface of the capillary, but also the viscosity coefficient of the BGE solution, the diffusion coefficients of the analytes, and the resolution and migration time of the analyte. Although different concentrations of sodium borate solutions (10, 25, 40, 50, and 60 mmol/L) were investigated, the peak of baicalin was gathered with other peaks and could not be separated if the concentration of sodium borate was lower than 50 mmol/L. With the concentration higher than 50 mmol/L, the state of separation was acceptable, but the signal noise was too high because of the strong electric current. Considered from all aspects, the 50 mmol/L borate solution was finally chosen as the BGE to obtain the greatest *F* value.

Effect of the adjunct

The separation was not obviously improved when β-CD and sodium heptanesulfonate were added to the 50-mmol/L sodium borate solution; the separation was improved when methanol was added due to its function of reducing the electroosmotic flow (EOF), but then the peak of baicalin tailed. The peak shape of baicalin improved when acetonitrile was added and the ratio of acetonitrile was adjusted to obtain the biggest *F* value when using 5% (v/v) acetonitrile.

Effect of pH

The pH of the BGE played an important role in the separating process, as it determined the extent of ionization and the UV absorbance of some acid compounds, thereby affecting their peak areas and resolution. Different pH values (8.5, 9.1, 9.3, 9.5, and 9.7) of the 50 mmol/L sodium borate solution (containing 5% acetonitrile) were selected as the BGE to find that the peak of baicalin split into two peaks with pH lower than 9.3, and that it may be deformed with a pH greater than 9.3. Therefore, the BGE was selected as pH 9.3 to obtain the greater *F* value.

Selection of the referential peak

During the selection of the referential peak, many substances were tested, such as caffeotannic acid, globulariacitrin, anilinparasulfonic acid, sodium benzoate, cardoverine, naproxen, etc. Both naproxen and baicalin contain a naphtalin ring in their structures, which result in the closer electrophoretic mobility. So naproxen was finally selected as the referential peak, with no disturbing peaks nearby.

Development of the referential CEFP

System suitability tests

The 450-µg/mL baicalin standard solution and the sample solution were injected, respectively, and the electropherograms were recorded. By comparing the migration times of peaks in the sample and standard electropherograms, the conclusion was drawn that the peak of 32.5 min was from baicalin, for which the theoretical plate number and the tailing factor were 4.28×10^4 and 0.97, respectively. The electropherograms described are shown in Figure 3A. For good separation (a resolution between the baicalin and naproxen peaks greater than 2.5) with the neighboring peaks and its moderate migration time, the peak of naproxen was selected as the referential peak.

Mark the common peaks

Sample solutions of *Radix Scutellariae* from the 10 different locations previously described were introduced into the CE system, and the electropherograms were recorded. By comparing the 10 CEFPs, eight common peaks were marked as the CEFP of *Radix Scutellariae*, in which the appearance ratio of each common peak in those CEFPs was 100%. The electro-

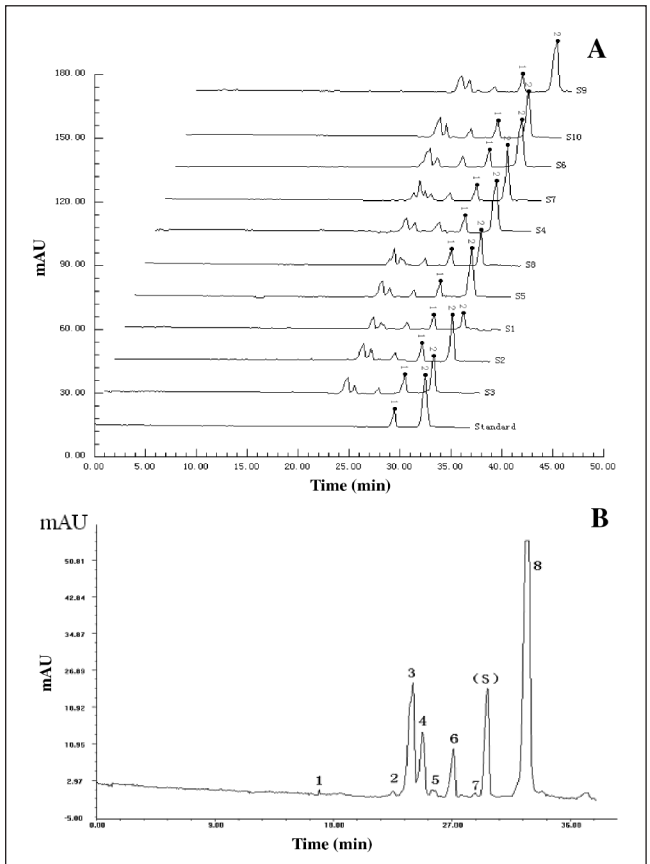

Figure 3. Electropherograms of baicalin standard and *Radix Scutellariae* samples: internal standard (naproxen) (1); baicalin (A) (2), and electropherogram of *Radix Scutellariae* produced in Yanqing. Sample: baicalin (8).

pherogram of *Radix Scutellariae* produced in Yanqing is shown in Figure 3B.

Injection precision test

The S1 solution of *Radix Scutellariae* was loaded six times successively, and the electropherograms were recorded. The relative standard deviations (RSD) of relative migration times of all the common peaks were between 0.13% and 2.78%, and the RSDs of relative peak areas were between 3.4% and 4.9%. This indicated that the method demonstrated good precision.

Stability of the solution

The S1 solution of *Radix Scutellariae* was loaded six times at regular intervals within 96 h, and the electropherograms were recorded. The RSDs of the relative migration times of all the common peaks were less than 4.8% within 72 h, and those of relative peak areas were less than 5.5% (within more than 72 h, the values became much larger), which indicated that the sample solution was stable within 72 h (reserved at 5°C).

Method repeatability

Five replicates of the S1 sample were accurately weighed, prepared as sample solutions according to the procedure previously mentioned, and then loaded, and the electropherograms were recorded. The RSDs of the relative migration time of all common peaks were below 3.9%, and that of relative peak areas was within 1.6–2.7%, which showed that the repeatability was satisfactory.

Development of the RCEFP

The peak of naproxen served as the referential peak, and the retention time (t_R), relative migration time (*RMT*), peak area (*A*), and relative peak area (*R.A.*) were used to mark the referential CEFP (RCEFP). These four parameters were all obtained from the average of corresponding data of the 10 batches of *Radix Scutellariae*. The data of the RCEFP are summarized in Table I.

Table I. The Data of RCEFP of *Radix Scutellariae*

No.	T (min)	(A μV·s)	R.T.	R.A.
1	16.25	1.03×10^4	0.533	0.020
2	23.09	1.59×10^4	0.758	0.030
3	24.73	5.86×10^5	0.811	1.124
4	25.42	1.98×10^5	0.834	0.381
5	26.16	3.39×10^4	0.858	0.065
6	27.85	2.30×10^5	0.913	0.441
7	29.21	7.03×10^3	0.958	0.014
(S)	30.49	5.21×10^5	1.000	1.000
8	33.51	1.60×10^6	1.099	3.078

Similarities of the distribution and the content of chemical constituents in *Radix Scutellariae*

There are many studies about *Radix Scutellariae* in the literature, in which many determinations of baicalein or baicalin as a crude drug or in its preparations by high-performance liquid chromatography, micellar electrokinetic capillary chromatography, or liquid chromatography–mass spectrometry have been reported, along with some research about fingerprints (12–15), but there is no overall quality control method of *Radix Scutellariae* by using CEFP associated with the determination of baicalin.

Suppose $\vec{X} = (x_1, x_2, \cdots, x_n)$ and $\vec{Y} = (y_1, y_2, \cdots, y_n)$. Here, x_i denotes the area of the *i*th common peak in the sample CEFP, and y_i refers that in the RCEFP; then, the qualitative similarity (S_F) is defined in equation 4, where S_F (16) indicates the similarity between each CEFP of the samples and the RCEFP for the distribution of chemical constituents in *Radix Scutellariae*; *O* is the vectorial angle between vectors $\vec{X}$ and $\vec{Y}$; and x_i and y_i are the same as those defined previously. The S_F results of *Radix Scutellariae* are shown in Table II, in which the S_F between every sample was known, and the RCEFP was > 0.90 to reveal the samples of with good similarities in chemical constituents distribution with the RCEFP.

$$S_F = \cos\theta = \frac{\sum_{i=1}^{n} x_i y_i}{\sqrt{\sum_{i=1}^{n} X_i^2 \sum_{i=1}^{n} y_i^2}} \qquad \text{Eq. 4}$$

According to vector theory, the projection of vector $\vec{X}$ on vector $\vec{Y}$ is described in equation 5, in which it is directly comparable to vector $\vec{Y}$ in length. Therefore, the apparently quantitative similarity (16) calculated by the vector projection (*C%*) can be defined as equation 6, in which the total content of all constituents in the sample CEFP can be authentically reflected to show how similar they are to that of the RCEFP. The *C%* is a perfect parameter to quantitatively represent the similarity of the content between the sample and the RCEFP (see Table II). Experiments (9) only using qualitative similarity (S_F) to evaluate the CEFP are not enough, because in the present paper it can be seen that, although the S_F values were all > 0.984

Table II. The Similarities Between Each Sample CEFP and the RCEFP of *Radix Scutellariae*

Para.	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
S_F	0.903	0.999	0.987	0.998	0.992	0.997	0.993	0.985	0.987	0.996
C%	38.2	97.4	83.0	91.1	113.8	137.5	105.5	72.2	148.4	112.9
P%	46.3	99.9	88.6	90.7	103.0	131.0	101.1	79.4	130.7	117.6
F	11.7	10.1	13.9	6.6	8.8	6.4	9.5	10.6	11.7	13.4
Fr	117644	1014574	1428274	65952	88557	62529	94439	107278	110199	133311
I	20.6	18.8	19.1	18.4	16.5	17.7	17.8	19.5	16.3	19.3
Ir	206268	189172	196591	183297	166085	173535	176467	196889	152936.7	191033

(except S1, 0.903), *C*% varied greatly, from 38.2% to 148.4%. This indicates that it is a more sensitive parameter in terms of reflecting the similarity of the overall content for all constituents in herbal medicine, which function is absolutely not possessed by S_F. Because the peak areas can reveal the contents when the weight of the crude drug, extracting methods, and loading volume are all settled, the ratio of the total peak areas of the sample CEFP to that of the RCEFP (*R*%) (17) was used to show the apparent quantitative similarity (see equation 7; x_i and y_i are the same as defined above). *R*% may result in a large error to some extent because it ignores the cross-compensation in areas of different components. In order to cancel out the error, the content similarity *P*% is used to disclose the overall content similarity between each CEFP and the RCEFP, shown in equation 8, where S_F and *R*% are the same as those defined previously. In general, both *C*% and *P*% are often combined to assess the content of a sample, and should be within 80–120%. S2, S3, S4, S5, S7, and S10 meet the requirements, but S1 and S8, with values less than 80%, and S6 and S9, with values greater than 120%, are not qualified.

$$|X| = \frac{\vec{X} \cdot \vec{Y}}{|\vec{Y}|} = \frac{\sum_{i=1}^{n} x_i y_i}{\sqrt{\sum_{i=1}^{n} y_i^2}} \quad \text{Eq. 5}$$

$$C\% = \frac{|X|}{|\vec{Y}|} \times 100\% = \frac{\sum_{i-1}^{n} x_i y_i}{\sum_{i=1}^{n} y_i^2} \times 100\% \quad \text{Eq. 6}$$

$$R\% = \frac{\sum_{i-1}^{n} x_i y_i}{\sum_{i=1}^{n} y_i} \times 100\% \quad \text{Eq. 7}$$

$$P\% = S_F \cdot R\% \quad \text{Eq. 8}$$

$$F_r = \frac{50F}{Q_m t} = \frac{50\beta\gamma \sum_{i-1}^{n} \lg x_i}{Q_m t} \quad \text{Eq. 9}$$

$$I = -\sum_{i-1}^{n} p_i \cdot \ln p_i \cdot \ln x_i \quad \text{Eq. 10}$$

$$I_r = \frac{50I}{Q_m t} = \frac{-50 \sum_{i-1}^{n} p_i \cdot \ln p_i \cdot \ln x_i}{Q_m t} \quad \text{Eq. 11}$$

The relative index of the chromatographic fingerprint, *Fr* (11), (equation 9); the index of the fingerprint information amount, *I* (18), (equation 10); and the relative index of the fingerprint information amount, *Ir* (18), (equation 11) could all be applied in evaluating the CEFPs of *Radix Scutellariae* in terms of the separation effect, the uniformity of peak signals, the magnitudes of common peak areas, and the characteristic information, where *t* is the migration time of the last peak in a CEFP; Q_m is the apparent injection mass (mg) calculated by the mass of a crude drug; p_i is the percentage of peak area for each common peak; and the other is the same as previously described. *Fr* and *Ir* are calibrated both by the migration time of the last peak based on the adequate separation time (50 min) and Q_m, and they are greatly higher than *F* and *I* to denote *Radix Scutellariae* with great efficiency in the chemical constituent information. Considering the influence of both storage and processing conditions, *F*, *Fr*, *I*, and *Ir* should be no less than 6.6, 65000, 16.5, and 166000, respectively, otherwise, they are not qualified (such as S6 and S9) (see Table II, in which the four indices might supply some digital information about the CEFPs).

Determination of baicalin in *Radix Scutellariae*

Calibration and linearity

A series of the standard solutions of baicalin was used to determine the linearity and linearity range of the analytes in the method developed. The calibration curve for these components was assessed at five concentration levels. Aliquots of a suitable volume (mL) of the standard stock solutions (0.25, 0.50, 1.25, 2.5, and 5.0) were pipetted and each of them was transferred into a 10-mL volumetric flask. Into each flask was added 1.0 mL of the referential peak solution and water to make exactly 10 mL, which was used to plot the calibration curve. Triplicate injections were performed at each concentration, and the average value was used to establish the standard curve. The linearity of standard curve was confirmed by plotting the relative peak area (*y*) against the concentration (*x*) of the standard. In the determination, the calibration graph was found to be linear in the aforementioned concentrations. The standard curve and correlation coefficient are shown in Table III.

Precision and reproducibility

To assess the precision of the method, the sample solution was injected six times within 24 h and over a three-day period of analysis. The intra- and inter-day coefficient variations studied were both less than 3.0% (Table III). Six replicate analyses of the same sample were made on different days to determine reproducibility. Table III shows results obtained from these assays. The RSD of the reproducibility is 3.4%. These results indicated that the present method can be used for the quantitative analysis of baicalin in *Radix Scutellariae*.

Stability of the sample solution

Sample solution was injected at 0, 12, 24, 48, 72, and 96 h, respectively, after preparing the solution. Results obtained from these assays are listed in Table III. The RSD of the stability is 4.6% within 72 h; then became much greater, which indicated that the solution was stable within 72 h.

Recoveries

Certain amounts of baicalin standard were added into the powdered drugs (S6) of known contents, and then prepared to obtain six sample solutions. Each was analyzed by the newly established method to acquire a high content of baicalin, which was subtracted from the content of bacailin in the initial sample solution to calculate the recoveries showed in Table IV. The average recovery was 100.9%, and the RSD was 2.24%, indicating that the accuracy of the method was good.

Application to the samples obtained in different areas

Each of the 10 crude sample solutions was loaded, and the

electropherograms were recorded. The contents of baicalin in *Radix Scutellariae* from different sources were calculated by the standard curve method, and the results obtained are listed in Table V. The contents of samples S4, S5, S6, S7, and S9 were all higher than 34.0 mg/g; the others were very low. According the CEFPs and the analyses of the mark compound, the conclusion was drawn that samples S4, S5, and S7 were better qualified, although with low contents of baicalin; samples S2 and S10 were also qualified. Samples S6 and S9 are not qualified because of their high contents, which may result in a poor quality of herbal preparations with surpassing dosage. Therefore, samples S1 and S8 should be mixed with samples S6 and S9 in terms of calculating weights to make S_F, *C%*, *P%, F*, *Fr*, *I,* and *Ir* meet the requirements.

Table III. Analytical Quality Parameters of the Proposed Method

Parameter	Baicalin	Slope	Intercept
Linearity			
Range (mg/mL)	0.09–1.8		
Equation	y = 0.0096x + 0.0805		
r^2	0.9994		
Intra-day Precision (*n* = 6)		**Intra-day Precision (*n* = 4)**	**Intra-day Precision (*n* = 4)**
Mean ± SD	44.3 ± 1.24 (mg/g)	0.0096 ± 0.00022	0.0805 ± 0.0013
RSD (%)	2.8	2.3	1.6
Inter-day Precision (*n* = 6)		**Inter-day Precision (*n* = 3)**	**Inter-day Precision (*n* = 3)**
Mean ± SD	45.6 ± 1.19 (mg/g)	0.0096 ± 0.00035	0.0805 ± 0.0021
RSD (%)	2.6	3.6	2.6
Reproducibility (*n* = 6)			
Mean ± SD (mg/g)	43.9 ± 1.49		
RSD (%)	3.4		
Solution Stability (0~72 h)			
Mean ± SD (mg/g)	42.8 ± 1.97		
RSD (%)	4.6		

Table IV. The Recovery of Baicalin

Added µg	Found µg	Recovery %	Mean %	RSD %
450	449.4	99.9		
450	451.4	100.3		
450	455.6	101.2	100.9	2.24
450	438.3	97.4		
450	463.7	103.0		
450	466.1	103.6		

Table V. The Contents of Baicalin in Radix Scutellariae from Different Sources (*n* = 3)

Sources	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
Content (mg/g)	13.7	28.1	20.5	42.5	43.5	44.1	34.8	21.0	50.8	32.8
RSD%	2.8	1.7	2.3	2.5	1.5	1.3	3.1	1.8	1.6	2.7

Conclusion

In this paper, the CEFP of *Radix Scutellariae* was established, and the content of baicalin was determined. The similarities between each sample's CEFP and the RCEFPs were evaluated in terms of both the distribution and the content of the constituents by the parameters S_F, *C%*, *P%*. *F*, *F*r, *I*, and *Ir*. The qualitative similarity S_F was combined with the quantitative similarities *C%* and *P%* to perfectly assess the quality of *Radix Scutellariae,* in which the method objectively, comprehensively, and truthfully revealed both the qualitative and quantitative information on the crude drug *Radix Scutellariae* produced in 10 different places. The index of chromatographic fingerprint *F* can effectively evaluate which CEFP was the best one under different experimental conditions, because it considered the effective separation rate (β), the leveling coefficients of common peak signals (γ), and the product of all common peak areas for comprehensive information, and so did *I*. *F*r and *Ir* took the time efficacy and chemical information in herbal drugs into consideration, which can reflect special information. In recent years, Guoxiang has developed several methods to control the quality of herbal drugs and invented the Microsoftware, Digitized Evaluation System for Super-information Characteristics of Tradi-tional Chinese Medicine Fingerprints, which can easily calculate the indices mentioned importing only the initial signals into it. The aim of this study was to provide a good quality control method for herbal medicines, in order to provide the best herbal drugs all over the world.

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