Table 1-1. The regression equations, concentration ranges and correlation coefficients of anthraquinones in rhubarb.

Constituents	Conc. ranges (μg/mL)	Regression equations	r^2
Aloe-emodin	1.2 ~ 50.0	Y=0.09532X-0.0343	0.9998
Rhein	6.2 ~ 200.0	Y=0.0708X+0.1300	0.9991
Emodin	1.2 ~ 50.0	Y=0.0717X-0.0151	0.9999
Chrysophenol	1.2 ~ 50.0	Y=0.0919X-0.0177	0.9984

Table 1-2. Intra-day and inter-day analytical precision and accuracy of aloe-emodin in methanol.

Conc. (μg/mL)	Precision				Accuracy	
	Intra-day		Inter-day		Intra-day	Inter-day
	Mean ± S.D.	(C.V.%)	Mean ± S.D.	(C.V.%)	Relative error (%)	Relative error (%)
50.0	49.9 ± 0.5	1.1	50.4 ± 1.0	2.0	-0.2	0.9
40.0	39.7 ± 0.5	1.2	40.0 ± 0.1	0.3	-0.8	0.0
20.0	20.0 ± 0.4	1.9	20.2 ± 0.5	2.3	-0.2	0.9
10.0	9.4 ± 0.2	1.7	9.6 ± 0.1	1.3	-6.0	-4.4
5.0	4.9 ± 0.1	2.3	4.9 ± 0.1	1.2	-2.6	-1.9
2.5	2.5 ± 0.1	2.2	2.6 ± 0.1	4.1	-0.1	2.5
1.2	1.4 ± 0.0	1.6	1.4 ± 0.0	0.0	11.7	12.7

附表

Table 1-3. Intra-day and inter-day analytical precision and accuracy of rhein in methanol

Conc. (μg/mL)	Precision				Accuracy	
	Intra-day		Inter-day		Intra-day	Inter-day
	Mean ± S.D.	(C.V.%)	Mean ± S.D.	(C.V.%)	Relative error (%)	Relative error (%)
200.0	197.9 ± 1.4	0.7	199.0 ± 2.1	1.0	-1.1	-0.5
150.0	148.9 ± 1.1	0.7	149.9 ± 0.7	0.5	-0.7	-0.1
100.0	102.1 ± 1.6	1.6	103.9 ± 0.0	0.0	2.1	3.9
50.0	52.1 ± 0.7	1.4	52.8 ± 0.5	1.0	4.3	5.7
25.0	27.1 ± 0.4	1.6	27.4 ± 0.3	1.2	8.5	9.5
6.2	5.3 ± 0.2	3.0	5.5 ± 0.1	1.5	-14.8	-12.6

Table 1-4. Intra-day and inter-day analytical precision and accuracy of emodin in methanol

Conc. (μg/mL)	Precision				Accuracy	
	Intra-day		Inter-day		Intra-day	Inter-day
	Mean ± S.D.	(C.V.%)	Mean ± S.D.	(C.V.%)	Relative error (%)	Relative error (%)
50.0	49.9 ± 0.3	0.6	50.3 ± 0.9	1.9	-0.1	0.6
40.0	39.8 ± 0.2	0.6	39.9 ± 0.3	0.7	-0.5	-0.4
20.0	19.4 ± 0.3	1.4	19.9 ± 0.4	2.1	-2.8	-0.6
10.0	9.9 ± 01	0.8	10.0 ± 0.2	2.1	-0.8	0.2
5.0	4.9 ± 0.1	1.5	4.9 ± 0.1	1.7	-2.7	-2.8
2.5	2.6 ± 0.0	0.0	2.6 ± 0.0	0.0	3.2	3.2
1.25	1.3 ± 0.0	0.0	1.4 ± 0.1	5.9	6.4	9.8

Table 1-5. Intra-day and inter-day analytical precision and accuracy of chrysophanol in methanol

Conc. (μg/mL)	Precision				Accuracy	
	Intra-day		Inter-day		Intra-day	Inter-day
	Mean ± S.D.	(C.V.%)	Mean ± S.D.	(C.V.%)	Relative error (%)	Relative error (%)
50.0	50.8 ± 0.5	1.1	49.9 ± 0.8	1.5	1.6	-0.1
40.0	40.5 ± 0.3	0.8	40.2 ± 0.2	0.5	1.3	0.6
20.0	18.2 ± 0.3	1.5	18.1 ± 0.2	0.9	-8.9	-9.6
10.0	10.7 ± 0.1	1.0	10.6 ± 0.1	1.0	7.4	6.4
5.0	5.1 ± 0.0	0.0	5.1 ± 0.1	1.2	1.8	2.5
2.5	2.5 ± 0.1	2.5	2.5 ± 0.1	2.5	2.1	0.5
1.2	1.4 ± 0.0	0.0	1.4 ± 0.0	0.0	11.2	11.1

Table 1-6. Recovery (%) of aloe-emodin from traditional decoction of Da Huang (n=3).

Conc. (μg/mL)	1	2	3	Mean ± S.D.
40.0	100.2	100.2	104.9	101.8 ± 2.7
20.0	97.5	101.8	103.3	100.9 ± 3.0
10.0	98.5	104.0	110.3	104.3 ± 5.9

Table 1-7. Recovery (%) of rhein from traditional decoction of Da Huang (n=3).

Conc. (μg/mL)	1	2	3	Mean ± S.D.
150.0	106.8	110.7	117.5	111.7 ± 5.4
75.0	104.7	111.5	111.2	109.1 ± 3.8
37.5	102.6	107.0	116.2	108.6 ± 6.9

Table 1-8. Recovery (%) of emodin from traditional decoction of Da Huang (n=3).

Conc. (μg/mL)	1	2	3	Mean ± S.D.
40.0	95.7	101.6	107.8	101.7 ± 6.1
20.0	100.6	106.6	108.0	105.1 ± 3.9
10.0	99.7	103.8	100.7	101.4 ± 2.1

Table 1-9. Recovery (%) of chrysophanol from traditional decoction of Da Huang (n=3).

Conc. (μg/mL)	1	2	3	Mean ± S.D.
40.0	103.2	98.7	106.3	102.7 ± 3.8
20.0	78.2	114.1	97.5	96.5 ± 18.1
10.0	104.2	105.1	104.9	104.7 ± 0.5

Table 1-10. Contents (μg/g) of total aloe-emodin, rhein, emodin and chrysophanol in decoctions of rhubarb (R) and rhubarb steamed with wine (RSW), respectively.

Constituents	R	RSW	P
Aloe-emodin	1170.5 ±25.3	966.222.8	0.009**
Rhein	3207.3 ±40.6	2707.9122.2	0.025*
Emodin	1362.4 ±13.9	1018.649.0	0.001**
Chrysophanol	704.7 ±13.3	604.531.3	0.026*

Data are expressed as Mean ± S.D. (n=3)

Table 1-11. Contents (μg/g) of aloe-emodin, rhein, emodin and chrysophanol in decoctions of rhubarb (R) and rhubarb steamed with wine (RSW), respectively.

Constituents	R	RSW	P
Aloe-emodin	412.9 ±5.6	301.39.5	0.004**
Rhein	2784.0 ±51.6	1789.157.3	0.002**
Emodin	537.6 ±6.6	377.213.5	0.005**
Chrysophanol	214.5 ±6.5	112.85.2	0.001***

Data are expressed as Mean ± S.D. (n=3)

Table 1-12. Contents (μg/g) of glycosides of aloe-emodin, rhein, emodin and chrysophanol in decoctions of rhubarb (R) and rhubarb steamed with wine (RSW), respectively.

Constituents	R	RSW	P
Aloe-emodin	757.6 ±25.3	664.9 ±22.8	0.008**
Rhein	423.3 ±40.6	918.9122.2	0.025*
Emodin	824.8 ±13.9	641.449.0	0.033*
Chrysophanol	490.2 ±13.3	491.731.3	0.933

Data are expressed as Mean ± S.D. (n=3)

P<0.05*

P<0.01**

P<0.001***

Table 1-13. Contents (μg/g) of aloe-emodin, rhein, emodin and chrysophanol in decoctions of rhubarb (R) and rhubarb steamed with wine (RSW).

	Constituents / type	Aloe-emodin	Rhein	Emodin	Chrysophanol
R	total	1171	3207	1362	705
	free form	413	2784	538	215
	glycosides	758	423	825	490
RSW	total	966	2708	1019	605
	free form	301	1789	377	113
	glycosides	665	919	641	492

Table 1-14. Contents (%) of aloe-emodin, rhein, emodin and chrysophanol in decoctions of rhubarb (R) and rhubarb steamed with wine (RSW)

	Constituents / type	Aloe-emodin	Rhein	Emodin	Chrysophanol	Total anthraquinones
R	total	0.12	0.32	0.14	0.07	0.65
	free form	0.04	0.28	0.05	0.02	0.39
	glycosides	0.08	0.04	0.08	0.05	0.25
RSW	total	0.10	0.27	0.10	0.06	0.53
	free form	0.03	0.18	0.04	0.01	0.26
	glycosides	0.07	0.09	0.06	0.05	0.27

Table 2-1. The regression equations, concentration ranges and correlation coefficients of anthraquinones in rat serum.

Constituents	Conc. ranges (μg/mL)	Regression equations	r^2
Aloe-emodin	0.1 ~ 10.0	Y=0.8240X+0.0147	0.9998
Rhein	0.8 ~ 50.0	Y=0.3799X+0.0445	0.9995
Emodin	0.2 ~ 10.0	Y=0.4167X-0.0100	0.9980
Chrysophenol	0.1~ 10.0	Y=0.4146X+0.0130	0.9977

Table 2-2. Intra-day and inter-day analytical precision and accuracy of aloe-emodin in rat serum.

Conc. (μg/mL)	Precision				Accuracy	
	Intra-day		Inter-day		Intra-day	Inter-day
	Mean ± S.D.	(C.V.%)	Mean ± S.D.	(C.V.%)	Relative error (%)	Relative error (%)
10.0	9.9 ± 0.1	1.2	9.9 ± 0.1	1.1	-0.7	-0.9
5.0	5.1 ± 0.1	0.6	5.1 ± 0.2	3.7	2.3	1.3
2.5	2.6 ± 0.1	1.9	2.6 ± 0.2	6.1	4.8	3.5
1.2	1.2 ± 0.0$_5$	1.8	1.2 ± 0.1	5.3	0.2	-0.9
0.6	0.6 ± 0.0$_1$	0.2	0.6 ± 0.0$_1$	1.6	-4.4	-2.5
0.3	0.3 ± 0.0$_1$	0.5	0.3 ± 0.0$_1$	2.5	-1.5	1.3
0.2	0.2 ± 0.0$_0$	1.2	0.2 ± 0.0$_0$	2.6	-1.0	1.5
0.1	0.1 ± 0.0	6.1	0.1 ± 0.0$_1$	7.8	-21.4	-17.6

Table 2-3. Intra-day and inter-day analytical precision and accuracy of rhein in rat serum.

Conc. (μg/mL)	Precision				Accuracy	
	Intra-day		Inter-day		Intra-day	Inter-day
	Mean ± S.D.	(C.V.%)	Mean ± S.D.	(C.V.%)	Relative error (%)	Relative error (%)
50.0	49.5 ± 1.0	2.0	49.3 ± 1.1	2.1	-1.0	-1.4
25.0	25.7 ± 0.1	0.3	25.5 ± 0.4	1.4	2.8	2.1
12.5	13.3 ± 0.3	2.2	13.3 ± 0.6	4.8	6.0	6.5
6.2	6.2 ± 0.2	2.7	6.2 ± 0.3	4.7	-0.0$_2$	-0.3
3.1	2.9 ± 0.0$_2$	0.6	2.9 ± 0.1	1.8	-7.8	-5.9
1.6	1.5 ± 0.0$_0$	0.3	1.5 ± 0.0$_3$	2.1	-3.9	-1.6
0.8	0.7 ± 0.0$_2$	2.1	0.7 ± 0.0$_2$	3.2	-6.2	-4.3

Table 2-4. Intra-day and inter-day analytical precision and accuracy of emodin in rat serum.

Conc. (μg/mL)	Precision				Accuracy	
	Intra-day		Inter-day		Intra-day	Inter-day
	Mean ± S.D.	(C.V.%)	Mean ± S.D.	(C.V.%)	Relative error (%)	Relative error (%)
10.0	9.9 ± 0.0$_3$	0.3	10.0 ± 0.2	1.5	-1.0	0.7
5.0	5.2 ± 0.0$_2$	0.3	5.2 ± 0.2	3.9	5.0	4.1
2.5	2.6 ± 0.0$_1$	0.5	2.6 ± 0.1	4.9	5.7	4.0
1.2	1.0 ± 0.1	5.5	1.0 ± 0.0$_1$	0.9	-13.7	-18.1
0.6	0.5 ± 0.0$_3$	5.6	0.5 ± 0.0$_1$	1.1	-16.2	-17.0
0.3	0.3 ± 0.0$_0$	1.2	0.3 ± 0.0$_1$	2.0	-4.7	-2.6
0.2	0.2 ± 0.0$_0$	2.3	0.2 ± 0.0$_0$	1.7	15.8	17.1

Table 2-5. Intra-day and inter-day analytical precision and accuracy of chrysophanol in rat serum.

Conc. (μg/mL)	Precision				Accuracy	
	Intra-day		Inter-day		Intra-day	Inter-day
	Mean ± S.D.	(C.V.%)	Mean ± S.D.	(C.V.%)	Relative error (%)	Relative error (%)
10.0	9.7 ± 0.1	0.8	10.0 ± 0.7	7.3	-3.1	0.4
5.0	$5.3 \pm 0.0_2$	0.4	$5.3 \pm 0.0_2$	0.3	5.8	5.3
2.5	$2.6 \pm 0.0_1$	0.2	$2.6 \pm 0.0_1$	0.2	4.0	4.4
1.2	$1.0 \pm 0.0_3$	2.7	$1.0 \pm 0.0_1$	1.3	-18.2	-18.8
0.6	$0.5 \pm 0.0_0$	0.1	$0.5 \pm 0.0_3$	4.9	-18.7	-14.4
0.3	$0.3 \pm 0.0_1$	4.9	$0.3 \pm 0.0_2$	6.0	-11.2	-12.1
0.2	$0.1 \pm 0.0_0$	2.0	$0.1 \pm 0.0_1$	5.5	-4.3	-7.5
0.1	$0.1 \pm 0.0_1$	9.0	$0.1 \pm 0.0_0$	1.2	-10.8	-7.2

Table2-6. Recovery (%) of aloe-emodin from rat serum (n=3).

Conc. (μg/mL)	1	2	3	Mean ±S.D.
2.0	94.1	88.0	89.5	90.5 ±3.2
1.0	90.6	92.0	89.0	90.5 ±1.5
0.5	87.0	107.8	95.8	96.9 ±10.4

Table 2-7. Recovery (%) of rhein from rat serum (n=3).

Conc. (μg/mL)	1	2	3	Mean ±S.D.
30.0	92.3	83.2	87.5	87.7 ±4.6
15.0	87.7	83.9	79.7	83.8 ±4.0
7.5	76.2	83.8	86.3	82.1 ±5.3

Table 2-8. Recovery (%) of emodin from rat serum.

Conc. (μg/mL)	1	2	3	Mean ±S.D.
4.0	87.3	77.2	83.9	82.8 ±5.1
2.0	83.3	73.9	85.7	81.0 ±6.2
1.0	78.5	100.4	104.5	94.5 ±14.0

Table 2-9. Recovery (%) of chrysophanol from rat serum (n=3).

Conc. (μg/mL)	1	2	3	Mean ±S.D.
4.0	86.2	78.1	83.4	82.6 ±4.1
2.0	84.3	75.3	94.5	84.7 ±9.6
1.0	97.0	95.6	103.4	98.7 ±4.2

Table 2-10. The serum concentrations (nmol/mL) of aloe-emodin sulfates in six rats after oral administration of decoction of rhubarb (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	2.8	2.4	2.3	2.0	4.0	1.8	2.6 ±0.3
30	3.4	3.3	2.8	3.2	3.4	1.8	3.0 ±0.2
60	3.4	3.0	2.6	3.0	1.7	0.7	2.4 ±0.4
120	1.3	1.9	2.5	1.7	0.9	0.7	1.5 ±0.3
180	0.6	1.4	1.2	0.7	0.5	0.2	0.7 ±0.2
300	0.1	0.1	0.0_3	0.1	0.0_3	0.0_0	0.1 ±0.0_2
480	0.0_2	0.1	0.0_2	0.0_0	0.0_0	0.0_0	0.0_2 ±0.0_1
720	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0 ±0.0_0

Table 2-11. The serum concentrations (nmol/mL) of aloe-emodin glucuronides in six rats after oral administration of decoction of rhubarb (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	2.6	2.1	2.7	1.9	3.3	1.6	2.3 ±0.2
30	3.2	3.2	2.0	3.0	2.9	1.5	2.6 ±0.3
60	3.4	2.9	2.5	3.3	1.3	0.8	2.4 ±0.4
120	1.3	1.9	2.3	1.8	0.7	0.7	1.4 ±0.3
180	0.5	1.3	1.2	0.6	0.4	0.3	0.7 ±0.2
300	0.1	0.1	0.0_1	0.1	0.0_3	0.0_1	0.0_4 ±0.0_1
480	0.0_0	0.1	0.0_0	0.0_0	0.0_0	0.0_0	0.0_1 ±0.0_1
720	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0 ±0.0_0

Table 2-12. The serum concentrations (nmol/mL) of rhein in six rats after oral administration of decoction of rhubarb (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	49.5	41.6	14.8	14.6	35.7	5.3	26.9 ±7.2
30	23.8	18.8	8.9	11.1	17.7	2.8	13.9 ±3.1
60	17.1	9.7	5.7	5.5	5.6	1.0	7.4 ±2.2
120	2.9	5.5	5.1	2.0	1.7	0.8	3.0 ±0.8
180	1.0	3.6	1.5	0.8	1.0	0.0_3	1.3 ±0.5
300	0.1	0.3	0.0_0	0.1	0.0_4	0.0_0	0.1 ±0.1
480	0.0_0	0.4	0.0_0	0.0_0	0.0_0	0.0_0	0.1 ±0.1
720	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0 ±0.0_0

Table 2-13. The serum concentrations (nmol/mL) of rhein sulfates in six rats after oral administration of decoction of rhubarb (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	35.2	29.3	33.4	34.6	55.3	27.6	35.9 ±4.1
30	37.3	27.6	32.5	36.2	35.9	23.5	32.1 ±2.3
60	32.7	27.8	28.1	33.9	17.7	11.3	25.3 ±3.6
120	16.9	19.2	27.2	20.7	8.1	10.1	17.0 ±2.9
180	8.4	16.3	14.7	8.5	4.8	3.3	9.3 ±2.1
300	1.4	1.7	1.2	1.7	1.1	0.3	1.2 ±0.2
480	0.5	1.2	1.3	0.4	0.4	0.3	0.7 ±0.2
720	0.0_0	0.1	0.0_3	0.0_0	0.4	0.3	0.1 ±0.1

Table 2-14. The serum concentrations (nmol/mL) of rhein glucuronides in six rats after oral administration of decoction of rhubarb (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	16.4	12.1	15.8	23.3	21.0	20.0	18.1 ±1.7
30	23.9	19.2	26.5	24.9	16.1	14.2	20.8 ±2.1
60	26.4	22.1	21.1	30.4	8.8	10.6	19.9 ±3.5
120	15.1	18.5	21.7	19.9	4.4	9.9	14.9 ±2.7
180	7.2	14.4	12.5	7.7	2.8	4.7	8.2 ±1.8
300	0.9	1.0	0.6	1.0	0.7	0.1	0.7 ±0.1
480	0.1	0.6	0.6	0.1	0.0_4	0.1	0.3 ±0.1
720	0.0_0	0.0_0	0.0_0	0.0_0	0.1	0.1	0.0_3 ±0.0_2

Table 2-15 The serum concentrations (nmol/mL) of emodin sulfates in six rats after oral administration of decoction of rhubarb (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	14.7	12.6	9.0	9.0	14.3	3.4	10.5 ±1.8
30	8.8	12.0	7.3	11.1	9.6	4.7	8.9 ±1.1
60	7.7	8.5	8.1	9.9	4.7	2.4	6.9 ±1.1
120	5.3	7.0	9.9	6.1	5.2	2.7	6.0 ±1.0
180	3.4	7.5	5.3	3.0	2.8	0.6	3.8 ±1.0
300	1.2	1.4	0.7	1.1	0.6	0.3	0.9 ±0.2
480	0.8	1.1	1.0	0.5	0.4	0.4	0.7 ±0.1
720	0.1	0.3	0.2	0.2	0.4	0.4	$0.3 \pm 0.0_5$

Table 2-16. The serum concentrations (nmol/mL) of emodin glucuronides in six rats after oral administration of decoction of rhubarb (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	14.2	12.2	9.4	9.8	8.3	5.3	9.9 ±1.3
30	12.4	11.8	9.6	10.4	6.0	2.8	8.8 ±1.5
60	10.7	11.5	5.5	11.4	3.1	3.1	7.5 ±1.7
120	5.8	8.5	9.5	7.0	3.0	2.7	6.1 ±1.1
180	3.2	7.9	5.4	3.1	2.8	1.6	4.0 ±0.9
300	1.1	1.4	0.8	0.9	0.7	0.4	0.9 ±0.1
480	0.8	1.7	0.8	0.6	0.3	0.3	0.8 ±0.2
720	0.2	0.5	0.3	0.2	0.3	0.2	$0.3 \pm 0.0_5$

Table 2-17. The serum concentrations (nmol/mL) of chrysophanol sulfates in six rats after oral administration of decoction of rhubarb (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	8.6	9.2	6.7	6.3	9.3	2.4	7.1 ±1.1
30	6.1	8.4	6.2	7.6	6.6	3.4	6.4 ±0.7
60	5.2	5.5	6.3	6.3	3.1	1.6	4.7 ±0.8
120	2.6	4.2	5.7	3.3	2.9	2.0	3.4 ±0.5
180	1.4	3.5	2.6	1.5	1.5	0.2	1.8 ±0.5
300	0.4	0.5	0.3	0.4	0.3	0.1	0.3 ±0.1
480	0.2	0.4	0.4	0.1	0.2	0.2	$0.2 \pm 0.0_5$
720	0.0_0	0.1	0.0_1	0.0_1	0.2	0.2	$0.1 \pm 0.0_4$

Table 2-18. The serum concentrations (nmol/mL) of chrysophanol glucuronides in six rats after oral administration of decoction of rhubarb (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	5.9	4.3	5.0	3.9	3.2	0.5	3.8 ±0.8
30	6.1	4.8	4.1	4.8	3.2	1.3	4.0 ±0.7
60	5.0	4.9	2.7	4.6	1.4	1.2	3.3 ±0.7
120	2.2	3.3	4.0	2.7	1.3	1.3	2.5 ±0.4
180	1.1	2.6	2.0	1.0	1.1	0.6	1.4 ±0.3
300	0.4	0.5	0.2	0.3	0.3	0.2	$0.3 \pm 0.0_5$
480	0.2	0.6	0.3	0.1	0.1	0.1	0.2 ±0.1
720	0.0_0	0.3	0.1	0.0_0	0.2	0.1	$0.1 \pm 0.0_5$

Table 2-19. The serum concentrations (nmol/mL) of aloe-emodin sulfates in six rats after oral administration of decoction of rhubarb steamed with wine (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean	±S.E.
10	2.3	3.1	3.9	4.6	2.9	2.5	3.2	±0.4
30	2.6	4.4	3.0	4.9	3.4	2.1	3.4	±0.4
60	2.4	2.4	1.7	2.1	2.8	1.5	2.2	±0.2
120	1.3	0.8	1.1	1.2	2.0	0.8	1.2	±0.2
180	0.5	0.9	1.2	1.0	1.1	0.7	0.9	±0.1
300	0.1	0.1	0.2	0.1	0.2	0.1	0.1	$\pm 0.0_3$
480	0.0_0	0.1	0.1	0.0_0	0.0_4	0.0_1	0.0_3	$\pm 0.0_1$
720	0.0_0	0.0_0	0.0_0	0.0_0	0.0_4	0.0_0	0.0_1	$\pm 0.0_1$

Table 2-20. The serum concentrations (nmol/mL) of aloe-emodin glucuronides in six rats after oral administration of decoction of rhubarb steamed with wine (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean	±S.E.
10	2.3	2.7	3.2	4.2	3.1	2.5	3.0	±0.3
30	2.4	3.9	3.5	4.5	3.6	2.2	3.3	±0.4
60	1.9	2.4	1.7	3.0	3.6	1.4	2.3	±0.3
120	1.0	0.8	1.1	1.2	2.2	0.7	1.2	±0.2
180	0.4	0.8	0.9	1.0	1.0	0.7	0.8	±0.1
300	0.0_4	0.1	0.2	0.1	0.2	0.0_3	0.1	$\pm 0.0_3$
480	0.0_0	0.0_1	0.1	0.0_0	0.0_1	0.0_0	0.0_2	$\pm 0.0_1$
720	0.0_0	0.0_0	0.0_1	0.0_0	0.0_2	0.0_0	0.0_1	$\pm 0.0_0$

Table 2-21. The serum concentrations (nmol/mL) of rhein in six rats after oral administration of decoction of rhubarb steamed with wine (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	21.9	25.8	33.2	41.7	41.3	14.7	29.8 ±4.4
30	12.6	19.5	18.5	23.4	15.5	5.0	15.7 ±2.6
60	6.5	8.2	5.0	8.1	8.6	3.2	6.6 ±0.9
120	1.5	1.5	1.7	2.0	3.1	0.8	1.7 ±0.3
180	0.4	0.8	1.7	1.7	1.3	1.3	1.2 ±0.2
300	0.2	0.0_0	0.5	0.3	0.0_0	0.0_0	0.2 ±0.1
480	0.0_0	0.0_0	0.2	0.0_0	0.0_0	0.0_0	0.0_4 ±0.0_4
720	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0	0.0_0 ±0.0_0

Table 2-22. The serum concentrations (nmol/mL) of rhein sulfates in six rats after oral administration of decoction of rhubarb steamed with wine (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	26.1	27.6	37.0	24.5	14.4	22.2	25.3 ±3.0
30	29.9	41.2	21.1	39.2	25.2	20.6	29.5 ±3.6
60	29.5	26.9	19.7	14.7	24.8	16.2	22.0 ±2.5
120	16.4	13.3	12.3	13.7	17.3	11.1	14.0 ±1.0
180	6.5	11.1	13.3	11.8	10.9	10.5	10.7 ±0.9
300	1.2	1.0	3.1	1.1	1.7	1.0	1.5 ±0.3
480	0.2	1.0	1.7	0.3	0.9	0.6	0.8 ±0.2
720	0.0_0	0.0_0	0.7	0.0_0	1.0	0.0_0	0.3 ±0.2

Table 2-23. The serum concentrations (nmol/mL) of rhein glucuronides in six rats after oral administration of decoction of rhubarb steamed with wine (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	17.2	8.9	20.4	11.5	16.4	15.5	15.0 ±1.7
30	17.8	25.8	24.2	23.7	23.2	17.0	21.9 ±1.5
60	14.9	22.1	19.8	28.4	28.7	13.5	21.2 ±2.7
120	11.1	12.3	12.6	13.7	18.0	9.6	12.9 ±1.2
180	5.0	9.3	10.7	11.8	9.4	9.0	9.2 ±0.9
300	0.7	0.4	2.4	1.0	2.0	0.6	1.2 ±0.3
480	0.1	0.3	1.7	0.1	0.6	0.2	0.5 ±0.2
720	0.0_0	0.0_0	0.4	0.0_0	0.7	0.0_0	0.2 ±0.1

Table 2-24. The serum concentrations (nmol/mL) of emodin sulfates in six rats after oral administration of decoction of rhubarb steamed with wine (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	7.8	8.0	7.3	7.9	6.1	4.5	6.9 ±0.6
30	8.6	8.5	3.7	15.0	4.7	5.1	7.6 ±1.7
60	4.6	3.9	2.3	3.3	3.9	3.1	3.5 ±0.3
120	2.6	2.3	3.6	3.0	3.1	1.8	2.7 ±0.3
180	1.5	2.8	3.3	4.7	4.6	2.0	3.1 ±0.5
300	0.5	0.6	1.2	0.7	1.8	0.4	0.9 ±0.2
480	0.3	0.5	0.5	0.4	0.8	0.4	0.5 ±0.1
720	0.0_0	0.0_0	0.5	0.2	0.5	0.0_0	0.2 ±0.1

Table 2-25. The serum concentrations (nmol/mL) of emodin glucuronides in six rats after oral administration of decoction of rhubarb steamed with wine (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	8.8	5.4	12.1	8.8	11.9	8.8	9.3 ±1.0
30	4.8	8.5	8.1	8.4	11.0	4.9	7.6 ±1.0
60	4.1	5.3	5.2	9.0	10.9	4.5	6.5 ±1.1
120	2.8	2.8	3.8	3.0	7.2	3.0	3.8 ±0.7
180	1.4	2.4	3.6	4.7	4.4	2.8	3.2 ±0.5
300	0.9	0.7	1.4	1.7	2.2	0.5	1.2 ±0.3
480	0.4	0.5	0.9	0.5	0.7	0.4	0.6 ±0.1
720	0.0_0	0.0_0	0.4	0.1	0.6	0.2	0.2 ±0.1

Table 2-26. The serum concentrations (nmol/mL) of chrysophanol sulfates in six rats after oral administration of decoction of rhubarb steamed with wine (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	4.9	5.4	5.3	5.8	4.8	3.5	4.9 ±0.3
30	5.5	6.0	2.8	10.9	3.4	3.5	5.4 ±1.2
60	2.8	2.5	1.5	2.2	2.6	2.2	2.3 ±0.2
120	1.2	1.0	1.9	1.3	1.8	1.0	1.4 ±0.2
180	0.7	1.4	1.8	1.9	2.0	1.0	1.5 ±0.2
300	0.1	0.2	0.8	0.3	0.8	0.2	0.4 ±0.1
480	0.0_0	0.2	0.3	0.2	0.3	0.1	$0.2 \pm 0.0_5$
720	0.0_2	0.0_0	0.3	0.0_0	0.3	0.0_0	0.1 ±0.1

Table 2-27. The serum concentrations (nmol/mL) of chrysophanol glucuronides in six rats after oral administration of decoction of rhubarb steamed with wine (5 g/kg).

Time (min) \ Rats	1	2	3	4	5	6	Mean ±S.E.
10	4.1	2.1	6.0	4.4	5.4	4.3	4.4 ±0.5
30	2.4	3.6	4.6	4.2	5.0	2.2	3.7 ±0.5
60	1.8	2.1	2.6	4.5	4.1	1.9	2.8 ±0.5
120	1.0	0.9	1.5	1.3	3.1	1.1	1.5 ±0.3
180	0.6	0.9	1.5	1.9	1.7	1.0	1.3 ±0.2
300	0.3	0.2	0.6	0.7	1.0	0.2	0.5 ±0.1
480	0.1	0.2	0.5	0.2	0.3	0.1	0.2 ±0.1
720	0.0_4	0.0_0	0.2	0.0_4	0.4	0.1	0.1 ±0.1

Table 2-28. Pharmacokinetic parameters of aloe-emodin sulfates and glucuronides in serum after oral administrations of decoction of R and RSW and (5 g/kg) to six rats.

Parameters	R	RSW
Sulfates		
T_{max} (min)	23.3 ± 4.2	23.3 ± 4.2
C_{max} (nmol/mL)	3.1 ± 0.3	3.6 ± 0.4
AUC_{0-720} (nmol·min·mL^{-1})	366.8 ± 52.1	398.5 ± 32.1
AUMC (nmol·min^2·mL^{-1})	3.1 (±0.66)E4	3.7 (±0.38) E4
MRT (min)	79.9 ± 7.3	93.1 ± 4.8
Glucuronides		
T_{max} (min)	30.0 ± 10.0	26.7 ± 3.3
C_{max} (nmol/mL)	2.9 ± 0.3	3.4 ± 0.3
AUC_{0-720} (nmol·min·mL^{-1})	346.3 ± 52.8	375.3 ± 50.2
AUMC (nmol·min^2·mL^{-1})	2.9 (±0.66)E4	3.2 (±0.58) E4
MRT (min)	80.3 ± 7.2	82.7 ± 6.6

Data are expressed as Mean ± S.E.

Table 2-29. Pharmacokinetic parameters of rhein, rhein sulfates and glucuronides in serum after oral administrations of decoction of R and RSW (5 g/kg) to six rats.

Parameters	R	RSW
rhein		
T_{max} (min)	10.0 ± 0.0$_0$	10.0 ± 0.0$_0$
C_{max} (nmol/mL)	26.9 ± 7.2	29.8 ± 4.4
AUC_{0-720} (nmol·min·mL^{-1})	1369.5 ± 337.9	1337.8 ± 186.7
AUMC (nmol·min^2·mL^{-1})	0.8 (±0.24)E5	0.7 (±0.11) E5
MRT (min)	54.0 ± 6.5	49.5 ± 3.8
Sulfates		
T_{max} (min)	16.7 ± 4.2	23.3 ± 4.2
C_{max} (nmol/mL)	36.5 ± 4.1	32.5 ± 3.2
AUC_{0-720} (nmol·min·mL^{-1})	4641.4 ± 510.2	4292.8 ± 212.0
AUMC (nmol·min^2·mL^{-1})	4.9 (±0.72)E5	5.1 (±0.62) E5
MRT (min)	103.1 ± 5.8	117.9 ± 10.3
Glucuronides		
T_{max} (min)	38.3 ± 10.1	40.0 ± 6.3
C_{max} (nmol/mL)	24.4 ± 1.6	23.7 ± 2.1
AUC_{0-720} (nmol·min·mL^{-1})	3457.5 ± 484.2	3620.5 ± 333.7
AUMC (nmol·min^2·mL^{-1})	3.6 (±0.6)E5	4.3 (±0.66) E5
MRT (min)	101.8 ± 4.7	116.2 ± 8.5

Data are expressed as Mean ± S.E.

Table 2-30. Pharmacokinetic parameters of emodin sulfates and glucuronides in serum after oral administrations of decoction of R, RSW and (5 g/kg) to six rats.

Parameters	R	RSW
Sulfates		
T_{max} (min)	35.0 ± 17.5	23.3 ± 4.2
C_{max} (nmol/mL)	11.2 ± 1.5	8.4 ± 1.4
AUC_{0-720} (nmol·min·mL^{-1})	1702.7 ± 247.8	1131.3 ± 122.6
AUMC (nmol·min^2·mL^{-1})	2.6 (±0.4)E5	1.8 (±0.36) E5
MRT (min)	158.0 ± 7.9	153.4 ± 18.2
Glucuronides		
T_{max} (min)	21.7 ± 8.3	21.7 ± 8.3
C_{max} (nmol/mL)	10.2 ± 1.3	9.9 ± 0.7
AUC_{0-720} (nmol·min·mL^{-1})	1757.6 ± 308.4	1449.9 ± 220.0
AUMC (nmol·min^2·mL^{-1})	2.8 (±0.55)E5	2.3 (±0.43) E5
MRT (min)	156.9 ±6.5	151.7 ± 8.9

Data are expressed as Mean ± S.E.

Table 2-31. Pharmacokinetic parameters of chrysophanol sulfates and glucuronides in serum after oral administrations of decoction of R, and RSW (5 g/kg) to six rats.

Parameters	R	RSW
Sulfates		
T_{max} (min)	16.7 ± 4.2	20.0 ± 4.5
C_{max} (nmol/mL)	7.5 ± 0.9	6.0 ± 1.0
AUC_{0-720} (nmol·min·mL^{-1})	941.8 ± 130.4	624.5 ± 62.1*
AUMC (nmol·min^2·mL^{-1})	1.1 (±0.17)E5	0.8 (±0.2) E5
MRT (min)	123.0 ± 10.0	128.4 ± 21.5
Glucuronides		
T_{max} (min)	28.3 ± 7.5	21.7 ± 8.3
C_{max} (nmol/mL)	4.2 ± 0.7	4.7 ± 0.4
AUC_{0-720} (nmol·min·mL^{-1})	685.3 ± 113.6	615.9 ± 103.9
AUMC (nmol·min^2·mL^{-1})	1.0 (±0.21)E5	1.0 (±0.22) E5
MRT (min)	144.7 ± 14.4	143.7 ± 12.3

Data are expressed as Mean ± S.E.

P<0.05*

P<0.01**

P<0.001***

Table 3-1. Intra-day and inter-day analytical precision and accuracy of emodin in rat serum.

Conc. (μg/mL)	Precision				Accuracy	
	Intra-day		Inter-day		Intra-day	Inter-day
	Mean ± S.D.	(C.V.%)	Mean ± S.D.	(C.V.%)	Relative error (%)	Relative error (%)
80.0	81.7 ± 2.1	2.6	79.8 ± 3.6	4.5	2.1	-0.3
40.0	39.7 ± 1.1	2.9	39.9 ± 1.0	2.6	-0.75	-0.4
20.0	20.7 ± 1.8	8.8	20.6 ± 1.9	9.0	3.4	3.2
10.0	10.2 ± 0.5	4.5	10.2 ± 0.5	4.6	2.5	2.3
5.0	4.7 ± 0.3	5.9	4.9 ± 0.2	4.1	-5.4	-1.8
2.5	2.5 ± 0.1	2.2	2.4 ± 0.1	4.4	-0.6	-4.5
1.2	1.3 ± 0.2	15.2	1.3 ± 0.2	14.1	6.5	7.6
0.6	$0.7 \pm 0.0_1$	2.3	$0.7 \pm 0.0_1$	1.2	9.7	11.0
0.3	$0.4 \pm 0.0_0$	0.6	$0.4 \pm 0.0_0$	0.9	17.9	19.4

Table 3-2. Recovery (%) of emodin from rat serum (n=3).

Conc. (μg/mL)	1	2	3	Mean ± S.D.
40.0	99.0	106.0	109.0	104.7 ± 5.1
20.0	92.0	98.0	100.9	99.7 ± 8.6
10.0	106.0	105.0	110.0	107.0 ± 2.6

Table 3-3. The serum concentrations (nmol/mL) of emodin sulfates in five rats after oral administration of emodin (50 mg/kg).

Rats / Time (min)	1	2	3	4	5	Mean ±S.E.
10	9.5	3.7	18.5	27.9	18.8	15.7 ±4.2
30	14.6	3.5	16.8	17.5	12.2	12.9 ±2.5
60	11.0	2.8	9.7	12.5	11.1	9.4 ±1.7
120	6.5	7.1	6.1	15.9	12.7	9.7 ±2.0
180	14.3	2.7	8.6	12.5	15.8	10.8 ±2.4
300	8.2	1.7	12.4	13.8	12.0	9.6 ±2.2
480	15.4	1.0	15.2	38.9	15.7	17.2 ±6.1
720	8.4	0.7	15.5	32.9	11.5	13.8 ±5.4
1440	4.5	6.9	12.8	6.4	9.0	7.9 ±1.4
2880	9.9	3.5	4.6	2.4	4.4.	5.0 ±1.3

Table 3-4. Individual pharmacokinetic parameters of emodin sulfates in serum after oral administration of emodin (50 mg/kg) to five rats.

Parameters	1	2	3	4	5	Mean ± S.E.
T_{max} (min)	480	120	10	480	10	220.0 ±108.0
C_{max} (nmol/mL)	15.4	7.1	18.5	38.9	18.8	19.7 ± 5.2
AUC_{0-2880} (nmol・min/mL)	2.3E4	1.2E4	3.2E4	3.8E4	2.7E4	2.6 ±(0.4)E4
$AUMC_{0-2880}$ (nmol・min^2 /mL)	3.3E7	1.9E7	3.7E7	3.1E7	3.0E7	3.0 (±0.3)E7
MRT (min)	1410.0	1583.9	1165.8	818.6	1106.8	1217.0 ± 131.4

Table 3-5. The serum concentrations (nmol/mL) of emodin glucuronides in five rats after oral administration of emodin (50 mg/kg).

Rats / Time (min)	1	2	3	4	5	Mean ±S.E.
10	7.2	2.6	21.6	21.0	18.0	14.1 ±3.9
30	11.0	2.4	17.9	12.6	17.4	12.3 ±2.8
60	8.7	2.3	11.5	10.3	12.7	9.1 ±1.8
120	6.0	5.3	8.7	12.1	13.2	9.1 ±1.6
180	12.6	2.2	10.8	8.7	15.7	10.0 ±2.3
300	6.7	1.2	13.8	9.9	14.4	9.2 ±2.4
480	12.0	0.9	18.1	29.7	15.7	15.3 ±4.7
720	5.6	0.6	17.6	20.8	15.0	12.0 ±3.8
1440	2.9	5.3	13.0	4.6	11.1	7.4 ±2.0
2880	5.7	2.4	5.3	1.8	4.9	4.0 ±0.8

Table 3-6. Individual pharmacokinetic parameters of emodin glucuronides in serum after oral administration of emodin (50 mg/kg) to five rats.

Parameters	1	2	3	4	5	Mean ± S.E.
T_{max} (min)	180	120	10	480	10	160.0 ± 86.4
C_{max} (nmol/mL)	12.6	5.3	21.6	29.7	18	17.4 ± 4.1
AUC_{0-2880} (nmol・min/mL)	1.6E4	0.9E4	3.5E4	2.7E4	3.2E4	2.4 ±(0.4)E4
$AUMC_{0-2880}$ (nmol・min^2 /mL)	2.0E7	1.4E7	4.0E7	2.2E7	3.5E7	2.6 (± 0.5)E7
MRT (min)	1279.9	1552.1	1141.7	822.5	1113.1	1181.8 ± 118.8

Table 3-7. Comparison of pharmacokinetic parameters of emodin sulfates and glucuronides in serum after oral administration of emodin (50 mg/kg) to five rats.

Parameters	Glucuronides	Sulfates
T_{max} (min)	160.0 ± 86.4	220.0 ± 108.0
C_{max} (nmol/mL)	17.4 ± 4.1	19.7 ± 5.2
$AUC_{0\text{-}2880}$(nmol·min·mL^{-1})	2.4 ± (0.5)E4	2.6 ±(0.4)E4
AUMC (nmol·min^2·mL^{-1})	2.6 (± 0.5)E7	3.0 (± 0.3)E7
MRT (min)	1181.8 ± 118.8	1217.0 ±131.4

Data are expressed as Mean ± S.E.

Table 3-8. The serum concentrations (nmol/mL) of emodin in five rats after intravenous administration of emodin (10 mg/kg).

Time (min) \ Rats	1	2	3	4	5	Mean ±S.E.
10	20.5	22.1	11.0	5.2	13.4	14.0 ±3.1
30	5.8	4.4	2.1	1.5	2.3	3.2 ±0.8
45	2.7	3.3	1.0	1.3	1.2	1.9 ±0.4
60	1.5	2.0	0.8	1.1	1.0	1.3 ±0.2
120	1.4	0.9	0.6	0.8	0.7	0.9 ±0.1
240	0.8	0.7	0.5	0.8	0.6	0.7 ±0.0
480	0.8	0.6	0.5	0.6	0.6	0.6 ±0.0
720	0.6	0.5	0.5	0.6	0.5	0.5 ±0.0

Table 3-9. Individual pharmacokinetic parameters of emodin in serum after intravenous administration of emodin (10 mg/kg) to five rats.

Parameters	1	2	3	4	5	Mean ± S.E.
A(nmol/mL)	39.8	68.7	27.5	11.6	36.5	36.8 ± 8.5
a(min^{-1})	0.072	0.134	0.098	0.103	0.107	0.103 ± 0.009
B(nmol/mL)	1.2	4.6	0.7	1.1	0.9	1.7 ± 0.7
ß(min^{-1})	0.001	0.012	0.001	0.001	0.001	0.003 ± 0.002
$t_{1/2}$a(min)	9.6	5.2	7.1	6.7	6.5	7.0 ± 0.7
$t_{1/2}$ß(min)	676.9	59.7	1347.0	669.9	777.9	706.3 ± 186.6
V_{ss}(mL)	5390.0	679.2	11504.0	8413.9	6295.3	6456.5 ± 1631.1
Cl_{tot}(mL·min^{-1})	8.0	16.3	7.2	9.6	7.5	9.7 ± 1.5
AUC_{0-720} (nmol·min·mL^{-1})	1767.4	908.8	1566.0	1152.0	1326.6	1344.2 ± 137.7
MRT(min)	677.4	41.7	1596.2	873.2	835.9	804.9 ± 226.4

附表

Table 3-10. The serum concentrations (nmol/mL) of emodin sulfates in five rats after intravenous administration of emodin (10 mg/kg).

Time (min) \ Rats	1	2	3	4	5	Mean ±S.E.
10	19.4	20.7	14.0	3.1	10.8	13.5 ±3.1
30	15.4	22.5	9.0	2.8	6.4	11.2 ±3.5
45	10.3	8.1	5.9	2.9	4.5	6.4 ±1.3
60	7.0	8.0	5.1	1.6	3.9	5.1 ±1.1
120	6.7	5.6	2.6	1.6	2.4	3.8 ±1.0
240	4.9	4.0	0.8	1.3	1.9	2.6 ±0.8
480	2.8	1.1	0.4	0.8	0.9	1.2 ±0.4
720	1.0	1.1	0.1	0.3	0.2	0.5 ±0.2

Table 3-11.Individual pharmacokinetic parameters of emodin sulfates in serum after intravenous administration of emodin (10 mg/kg) to five rats.

Parameters	1	2	3	4	5	Mean ± S.E.
A(nmol/mL)	17.1	22.8	13.2	1.6	11.4	13.2 ± 3.2
a(min^{-1})	0.033	0.023	0.037	0.021	0.044	0.032 ± 0.004
B(nmol/mL)	7.4	4.7	5.3	1.9	3.5	4.6 ± 0.8
ß(min^{-1})	0.002	0.002	0.007	0.002	0.003	0.003 ± 0.001
$t_{1/2a}$(min)	21.3	29.5	18.8	32.8	15.8	23.6 ± 3.0
$t_{1/2ß}$(min)	321.6	336.9	99.5	334.6	231.3	264.8 ± 41.7
V_{ss}(mL)	1442.3	1605.6	1073.0	4941.2	1921.9	2196.8 ± 638.6
Cl_{tot}($mL \cdot min^{-1}$)	3.5	4.5	10.1	11.0	6.9	7.2 ± 1.3
AUC_{0-720} ($nmol \cdot min \cdot mL^{-1}$)	3966.3	3265.9	1119.6	1009.4	1442.8	2160.8 ± 555.5
MRT(min)	406.8	354.3	106.4	449.3	277.5	318.9 ± 55.1

Table 3-12. The serum concentrations (nmol/mL) of emodin glucuronides in five rats after intravenous administration of emodin (10 mg/kg).

Rats / ime (min)	1	2	3	4	5	Mean ±S.E.
10	20.7	7.0	13.3	2.4	11.3	10.9±3.1
30	18.8	9.4	6.9	2.3	6.1	8.7±2.8
45	8.5	5.9	5.8	1.6	5.5	5.5±1.1
60	5.7	4.5	4.4	1.4	3.9	4.0±0.7
120	3.6	3.5	2.1	1.7	2.0	2.6±0.4
240	3.8	3.4	0.8	1.4	1.7	2.2±0.6
480	2.0	1.2	0.4	0.9	1.0	1.1±0.3
720	0.7	0.7	0.2	0.3	0.1	0.4±0.1

Table 3-13. Individual pharmacokinetic parameters of emodin glucuronides in serum after intravenous administration of emodin (10 mg/kg) to five rats.

Parameters	1	2	3	4	5	Mean ± S.E.
A(nmol/mL)	24.8	4.3	17.3	1.1	11.9	11.9 ± 3.9
a(min^{-1})	0.027	0.016	0.124	0.054	0.038	0.052 ± 0.017
B(nmol/mL)	3.2	4.6	9.3	1.9	3.1	4.4 ± 1.2
ß(min^{-1})	0.001	0.002	0.012	0.002	0.003	0.004 ± 0.002
$t_{1/2a}$(min)	25.7	44.0	5.6	12.7	18.2	21.3 ± 6.0
$t_{1/2ß}$(min)	582.7	285.0	58.4	396.1	240.1	312.4 ± 79.2
V_{ss}(mL)	2479.3	2536.4	886.6	5743.0	1964.6	2722.0 ± 740.6
Cl_{tot}($mL \cdot min^{-1}$)	3.9	6.9	12.2	10.2	7.2	8.1 ± 1.3
AUC_{0-720} ($nmol \cdot min \cdot mL^{-1}$)	3605.5	2142.6	926.1	1085.1	1395.3	1830.9 ± 447.7
MRT(min)	635.7	367.2	72.8	561.4	274.4	382.3 ± 92.2

附表

Table 3-14. Comparison of pharmacokinetic parameters of emodin, emodin sulfates and emodin glucuronides in serum after intravenous administration of emodin (10 mg/kg) to five rats.

Parameters	Emodin	Sulfates	Glucuronides
A(nmol/mL)	36.8 ± 8.5	13.2 ± 3.2	11.9 ± 3.9
a(min^{-1})	0.103 ± 0.009	0.032 ± 0.004	0.052 ± 0.017
B(nmol/mL)	1.7 ± 0.7	4.6 ± 0.8	4.4 ± 1.2
ß(min^{-1})	0.003 ± 0.002	0.003 ± 0.001	0.004 ± 0.002
$t_{1/2a}$(min)	7.0 ± 0.7	23.6 ± 3.0	21.3 ± 6.0
$t_{1/2ß}$(min)	706.3 ± 186.6	264.8 ± 41.7	312.4 ± 79.2
V_{ss}(mL)	6456.5 ± 1631.1	2196.8 ± 638.6	2722.0 ± 740.6
Cl_{tot}(mL·min^{-1})	9.7 ± 1.5	7.2 ± 1.3	8.1 ± 1.3
AUC_{0-720} (nmol·min·mL^{-1})	1344.2 ± 137.7	2160.8 ± 555.5	1830.9 ± 447.7
MRT(min)	804.9 ± 226.4	318.9 ± 55.1	382.3 ± 92.2

Data are expressed as Mean ± S.E.

Table 3-15. Individual AUC_{0-720} of emodin, emodin sulfates and glucuronides in serum after intravenous administration of emodin (10 mg/kg) to five rats.

Parameters	1	2	3	4	5	Mean ± S.E.
Emodin AUC_{0-720} (nmol・min/mL)	1039.8	944.0	570.8	597.0	671.8	764.7 ±95.4
Emodin sulfates AUC_{0-720} (nmol・min/mL)	3248.5	2745.8	1133.3	805.0	1285.8	1843.7 ± 483.8
Emodin glucuronides AUC_{0-720} (nmol・min/mL)	2552.8	1825.8	1025.3	809.8	1243.0	1491.3 ±314.8

Table 4-1. Contents (μg/g) of anthraquinones in decoctions of Hu Zhang, and Da Huang.

Anthraquinones (μg/g)	Hu Zhang	Da Huang
Aloe-emodin	ND	116
Rhein	ND	985
Emodin	628	117
Chrysophanol	ND	89

ND: not detected

Table 4-2. Cyclosporine blood concentrations (ng/mL) of five rats after oral administrations of cyclosporine (1.25 mg/kg) with tetraglycol/PEG400 (1:1) to five rats

Time (min) \ Rats	A	B	C	D	E	Mean ±S.E.
20	108.9	59.1	82.1	50.0	82.4	76.5 ±10.3
40	149.5	94.6	174.7	54.5	85.3	111.7 ±22.0
60	132.5	70.7	148.0	52.8	88.6	98.5 ±18.1
180	113.3	72.6	96.6	57.1	84.2	84.8 ±9.7
300	93.0	60.4	72.3	54.2	73.1	70.6 ±6.6
540	58.6	39.9	41.5	41.6	53.6	47.1 ±3.8

Table 4-3. Cyclosporine blood concentrations (ng/mL) of six rats after oral coadministration of cyclosporine (1.25 mg/kg) with emodin (40 mg/kg).

Time (min) \ Rats	A	B	C	D	E	F	Mean ±S.E.
20	11.0	45.7	16.4	18.9	25.0	19.5	22.7 ±5.0
40	27.5	54.5	25.3	37.5	20.6	20.1	30.9 ±5.4
60	15.1	39.2	13.8	15.2	22.9	18.3	20.7 ±3.9
180	13.9	34.3	15.1	21.5	23.7	21.5	21.7 ±3.0
300	19.8	31.7	17.5	21.2	24.5	20.8	22.6 ±2.0
540	16.9	24.0	24.0	24.6	24.0	22.0	22.6 ±1.2

Table 4-4. Comparison of pharmacokinetic parameters of cyclosporine in rats after oral administrations of cyclosporine alone (n=6) and coadministration with emodin (40 mg/kg) (n=5).

Parameters	**cyclosporine** Mean±S.E	**cyclosporine+emodin** Mean±S.E	**Difference** (%)	P
T_{max} (min)	72.0 ±27.3	120.0 ± 84.1	66.7	0.630
C_{max}(ng·mL^{-1})	112.9 ±21.4	32.0 ±5.0	-71.7	0.003**
AUC_{0-540} (ng·min·mL^{-1})	3.92 (±0.44)E4	1.19 (± 0.12)E4	-69.5	<0.001***
AUMC (ng·min^2·mL^{-1})	9.23 (±0.85)E6	3.28 (± 0.22)E6	-64.4	<0.001***
MRT (min)	238.2 ± 8.5	278.0 ± 7.6	16.7	0.007**

P<0.05*

P<0.01**

P<0.001***

Table 4-5. Cyclosporine blood concentrations (ng/mL) of five rats after oral administration of cyclosporine (2.5 mg/kg) .

Time (min) \ Rats	A	B	C	D	E	Mean ±S.E.
20	735.8	578.8	572.4	622.4	676.0	637.1 ±30.8
40	1300.1	805.9	646.4	775.8	985.1	902.7 ±113.1
60	1016.6	674.6	717.3	718.0	1044.8	834.3 ±80.7
180	790.4	390.0	333.8	389.9	580.3	496.9 ±84.4
300	648.0	245.1	260.8	228.5	311.3	338.7 ±78.6
540	369.9	94.0	107.3	134.9	123.7	166.0 ±51.5

Table 4-6 Cyclosporine blood concentrations (ng/mL) of five rats after oral administrations of cyclosporine (2.5 mg/kg) and traditional decoction of Da Huang (0.25 g/kg).

Time (min) \ Rats	A	B	C	D	E	Mean ±S.E.
20	183.7	112.5	164.2	104.9	96.8	132.4 ±17.4
40	378.1	129.3	222.6	135.7	123.4	197.8 ±48.6
60	441.8	129.3	186.7	126.0	87.2	194.2 ±63.9
180	363.1	805.5	360.8	217.2	45.2	358.4 ±126.1
300	210.4	57.3	878.9	88.6	34.5	253.9 ±159.2
540	91.9	30.7	26.6	13.5	13.2	35.1 ±14.6

Table 4-7. Pharmacokinetic parameters of cyclosporine in rats (n=5) after oral administrations of cyclosporine (2.5 mg/kg) alone and coadministration with decoction of Da Huang (0.25 g/kg).

Parameters	**cyclosporine** Mean±S.E	**cyclosporine+decoction** Mean±S.E	**Difference** (%)	p
T_{max} (min)	48.0 ±4.9	152 ± 47.2	216.7	0.090
C_{max}(ng·mL^{-1})	928.8 ±108.3	493 ±152.0	-46.9	0.120
AUC_{0-540} (ng·min·mL^{-1})	2.3 (±0.37)E5	1.1 (± 0.35)E5	-50.8	0.095
$AUMC_{0-540}$ (ng·min^2·mL^{-1})	4.4 (±0.96)E7	2.5 (± 0.93)E7	-44.1	0.229
MRT_{0-540} (min)	187.9 ± 8.7	203.2 ± 14.2	8.2	0.378

Table 4-8. Pharmacokinetic parameters of cyclosporine in rats (n=5) after oral administration of cyclosporine (2.5 mg/kg) alone and coadministration with decoction of Da Huang (0.25 g/kg).

Parameters	**cyclosporine** Mean±S.E	**cyclosporine+decoction** Mean±S.E	**Difference** (%)	p
T_{max} (min)	48.0 ±4.9	128.0 ± 32.0	166.7	0.075
C_{max}(ng·mL^{-1})	928.8 ±108.3	389.7 ±117.7	-58.0	0.033*
AUC_{0-180}(ng·min·mL^{-1})	1.2 (±0.13)E5	0.4 (± 0.1)E5	-65.0	0.009**
$AUMC_{0-180}$ (ng·min^2·mL^{-1})	1.0 (±0.13)E7	0.5 (± 0.14)E7	-50.3	0.080
MRT (min)	82.0 ± 1.9	110.3 ± 12.5	34.6	0.104

P<0.05*

P<0.01**

P<0.001***

Table 4-9. Cyclosporine blood concentrations (ng/mL) of six rats after oral administration of cyclosporine (2.5 mg/kg) .

Time (min) \ Rats	A	B	C	D	E	F	Mean ±S.E.
20	382.7	459.5	269.1	701.3	515.7	572.4	483.5 ±86.8
40	573.8	757.4	652.7	239.5	961.1	646.4	638.5 ±137.1
60	633.6	557.9	710.1	910.6	982.9	717.3	752.1 ±94.2
180	420.9	507.6	587.5	637.8	641.4	333.8	521.5 ±72.0
300	347.6	350.0	363.4	425.5	441.8	260.8	364.9 ±37.4
540	202.1	231.9	234.6	252.0	237.5	107.3	210.9 ±30.8

Table 4-10. Cyclosporine blood concentrations (ng/mL) of six rats after oral coadministration of cyclosporine (2.5 mg/kg) with decoction of Hu Zhang (2 g/kg).

Time (min) \ Rats	A	B	C	D	E	F	Mean ±S.E.
20	26.3	41.8	41.1	69.6	48.6	58.2	47.6 ±8.7
40	65.7	33.4	67.5	105.4	152.1	75.0	83.2 ±23.6
60	75.9	41.2	89.1	122.1	190.4	77.4	99.3 ±29.8
180	87.4	15.4	118.5	278.0	242.2	63.5	134.1 ±59.9
300	80.8	34.7	169.1	226.3	172.8	46.0	121.6 ±45.3
540	59.9	27.1	120.1	118.1	94.0	21.6	73.4 ±25.3

Table 411. Comparison of pharmacokinetic parameters of cyclosporine in rats (n=6) after oral administration of cyclosporine (2.5 mg/kg) alone and coadministration with traditional decoction of Hu Zhang (2 g/kg).

Parameters	**cyclosporine** Mean±S.E	**cyclosporine+decoction** Mean±S.E	**Difference** (%)	p
T_{max} (min)	56.7 ±3.3	153.33 ± 40.9	170.6	0.055
C_{max} (ng/mL)	785.3 ±54.4	149.3 ± 39.2	-80.9	<0.001***
AUC_{0-540}(ng·min·mL^{-1})	22.9 (±1.66)E4	5.64 (± 1.41)E4	-75.3	<0.001***
AUMC (ng·min^2·mL^{-1})	48.5 (±3.96)E6	14.7 (± 3.76)E6	-69.6	<0.001***
MRT (min)	211.4 ± 6.1	258.1 ± 11.3	22.1	0.001**

P<0.05*

P<0.01**

P<0.001***

附表

Table 4-12. Cyclosporine blood concentrations (ng/mL) of seven rats after intravenous administration of cyclosporine (0.8 mg/kg) .

Rats / Time (min)	A	B	C	D	E	F	G	Mean ±S.E.
5	1295.5	1265.3	1330.6	1002.6	1244.0	970.7	1000.5	1158.5 ±60.1
10	959.9	763.3	1055.7	746.9	795.8	897.8	895.8	873.6 ±42.5
20	663.4	492.6	494.1	636.4	541.9	612.3	482.2	560.4 ±28.7
40	500.9	376.4	465.3	556.0	500.3	392.9	403.3	456.4 ±25.4
60	365.9	251.1	400.7	514.0	384.4	349.5	329.7	370.8 ±30.1
180	242.8	190.7	280.9	314.0	310.5	181.5	192.5	244.7 ±21.7
300	158.2	173.5	163.1	217.3	162.4	130.1	124.7	161.3 ±11.6
540	82.9	60.9	93.2	179.6	119.7	49.4	46.8	90.4 ±17.8

Table 4-13. Cyclosporine blood concentrations (ng/mL) of seven rats after coadministration of cyclosporine (0.8 mg/kg, i.v.) and decoction of Da Huang (0.25 g/kg, p.o) .

Time (min) \ Rats	A	B	C	D	E	F	G	Mean ±S.E.
5	1341.2	1349.4	1529.2	1148.5	1538.3	1458.9	1508.5	1410.6 ±53.4
10	858.8	991.6	828.9	874.7	1026.9	829.2	1297.0	958.2 ±63.8
20	523.7	651.4	671.8	623.6	759.6	735.8	868.5	690.6 ±41.6
40	469.5	496.7	575.2	521.3	646.4	546.4	750.2	572.2 ±36.7
60	388.5	425.0	408.9	448.6	580.3	595.1	633.0	497.1 ±38.5
180	389.9	225.7	447.7	350.7	356.6	544.6	386.1	385.9 ±36.8
300	449.1	143.9	440.9	230.0	194.5	493.9	216.8	309.9 ±54.8
540	202.8	106.1	275.4	180.0	77.3	180.3	108.0	161.4 ±26.0

附圖

Table 4-14. Comparison of pharmacokinetic parameters of cyclosporine in rats (n=7) after intravenous administration of cyclosporine (0.8 mg/kg) alone and oral coadministration with decoction of Da Huang (0.25 g/kg).

Parameters	**cyclosporine** Mean±S.E	**cyclosporine+decoction** Mean±S.E	**Difference** (%)	p
A(ng/mL)	1.3 ± 0.2	2.1 ± 0.4	57.3	0.120
α (min^{-1})	0.1 ± 0.0	0.2 ± 0.0	44.2	0.251
B(ng/mL)	0.5 ± 0.0	0.6 ± 0.0	35.2	0.057
β (min^{-1})	0.003 ± 0.000	0.003 ± 0.001	-20.1	0.273
$t_{1/2\alpha}$(min)	6.8 ± 1.3	4.7 ± 0.7	-31.3	0.262
$t_{1/2\beta}$(min)	203.7 ± 7.1	344.6 ± 78.7	69.2	0.127
V_{ss} (mL)	399.3 ± 29.3	328.7 ± 28.6	-17.7	0.164
Cl_{tot}(mL·min^{-1})	1.5 ± 0.2	0.9 ± 0.2	-40.6	0.027*
AUC_{0-540}(ng·min·mL^{-1})	149.1 ± 12.3	302.3 ± 53.3	102.8	0.032*
MRT (min)	269.9 ± 11.8	478.8 ± 112.2	77.4	0.117

P<0.05*
P<0.01**
P<0.001***

Table 5-1. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted jejunum of rats (n=3, control).

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	16	104	157	92 ± 41
40	44	106	192	114 ± 43
60	147	212	276	212 ± 37
80	310	311	325	315 ± 5
100	429	402	374	402 ± 16

Table 5-2. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted jejunum of rats (n=3) in the presence of Da Huang decoction (1.25 mg/mL).

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	23	20	26	23 ± 2
40	54	38	69	54 ± 9
60	116	100	132	116 ± 9
80	180	153	190	174 ± 11
100	236	224	247	236 ± 7

Table 5-3. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted jejunum of rats (n=3) in the presence of Hu zhang decoction (10 mg/mL).

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	8	10	6	8 ± 1
40	11	21	6	13 ± 4
60	16	23	13	17 ± 3
80	22	27	18	22 ± 3
100	33	31	30	31 ± 1

Table 5-4. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted ileum of rats（n=3, control）.

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	48	18	20	29 ± 8
40	95	70	42	69 ± 15
60	103	80	110	98 ± 9
80	127	200	134	154 ± 23
100	161	222	144	176 ± 24

Table 5-5. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted ileum of rats（n=3）in the presence of Da Huang decoction (1.25 mg/mL).

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	13	14	29	19 ± 5
40	16	25	43	28 ± 8
60	37	54	75	55 ± 11
80	57	80	110	82 ± 15
100	102	126	146	125 ± 13

Table 5-6. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted ileum of rats（n=3）in the presence of Hu Zhang decoction (10 mg/mL).

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	5	0	5	3 ± 2
40	6	8	9	8 ± 1
60	8	11	9	9 ± 1
80	10	20	12	14 ± 3
100	13	28	12	18 ± 5

Table 5-7. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted jejunum of rats (n=3, control).

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	15	17	113	48 ± 32
40	67	62	136	88 ± 24
60	157	131	359	216 ± 72
80	260	186	592	346 ± 125
100	397	303	739	480 ± 133

Table 5-8. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted jejunum of rats (n=3) in the presence of emodin (0.2 mg/mL).

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	8	212	55	92 ± 62
40	29	253	149	144 ± 65
60	74	297	193	188 ± 64
80	133	306	254	231 ± 51
100	202	426	316	315 ± 65

Table 5-9. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted ileum of rats (n=3, control).

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	11	36	17	21 ± 6
40	34	82	38	51 ± 15
60	94	125	71	97 ± 16
80	157	394	130	227 ± 84
100	270	639	171	360 ± 142

Table 5-10. Transport of rhodamine 123 (ng/mL) from serosal to mucosal side across the everted ileum of rats (n=3) in the presence of emodin (0.2 mg/mL).

Time (min) \ Rats	1	2	3	Mean ± S.E.
20	6	7	7	7 ± 0.3
40	21	15	21	19 ± 2
60	52	47	23	41 ± 9
80	95	147	73	105 ± 22
100	182	492	123	266 ± 114