

Quantitative determination of diosmin in tablets by infrared and Raman spectroscopy

Sonia Pielorz, Magdalena Węglińska, Sylwester Mazurek, Roman Szostak

Department of Chemistry, University of Wrocław, 14F, Joliot-Curie, 50-383 Wrocław, Poland

SUPPLEMENTARY MATERIALS

Table of contents:

Fig. S1 Raman, MIR and NIR spectra of Preparation 1, diosmin hydrate, polyvinyl alcohol, croscarmellose sodium and magnesium stearate; from the top	2
Fig. S2 Experimental Raman, MIR and NIR spectra of hydrated (DSNM) and anhydrous (DSNA) diosmin	3
Fig. S3 Calculated Raman and IR spectra of hydrated (DSNM) and anhydrous (DSNA) diosmin; abscissa scale multiplied by a factor of 0.98; Gauss Lorentz profile with a half width of 8.9 cm^{-1} was used to obtain calculated spectra	3
Fig.S4 Loadings plots of PCA models obtained on the basis of Raman, DRIFTS/MIR and DRIFTS/NIR spectra of calibration samples	4
Fig. S5 Regression vectors obtained on the basis of Raman, MIR and NIR spectra of calibration samples.....	4
Tab. S1 Basic data on the analyzed preparations	5
Tab. S2 Composition of calibration samples [mf]	6
Tab. S3 API content in the studied preparations [mf]	8
Tab. S4 Band assignment in the Raman and MIR spectra of diosmin.....	8
Tab. S5 Parameters of PLS models for preparations 2-8	9
Tab. S6 Diosmin recovery [%] (n=10)	11

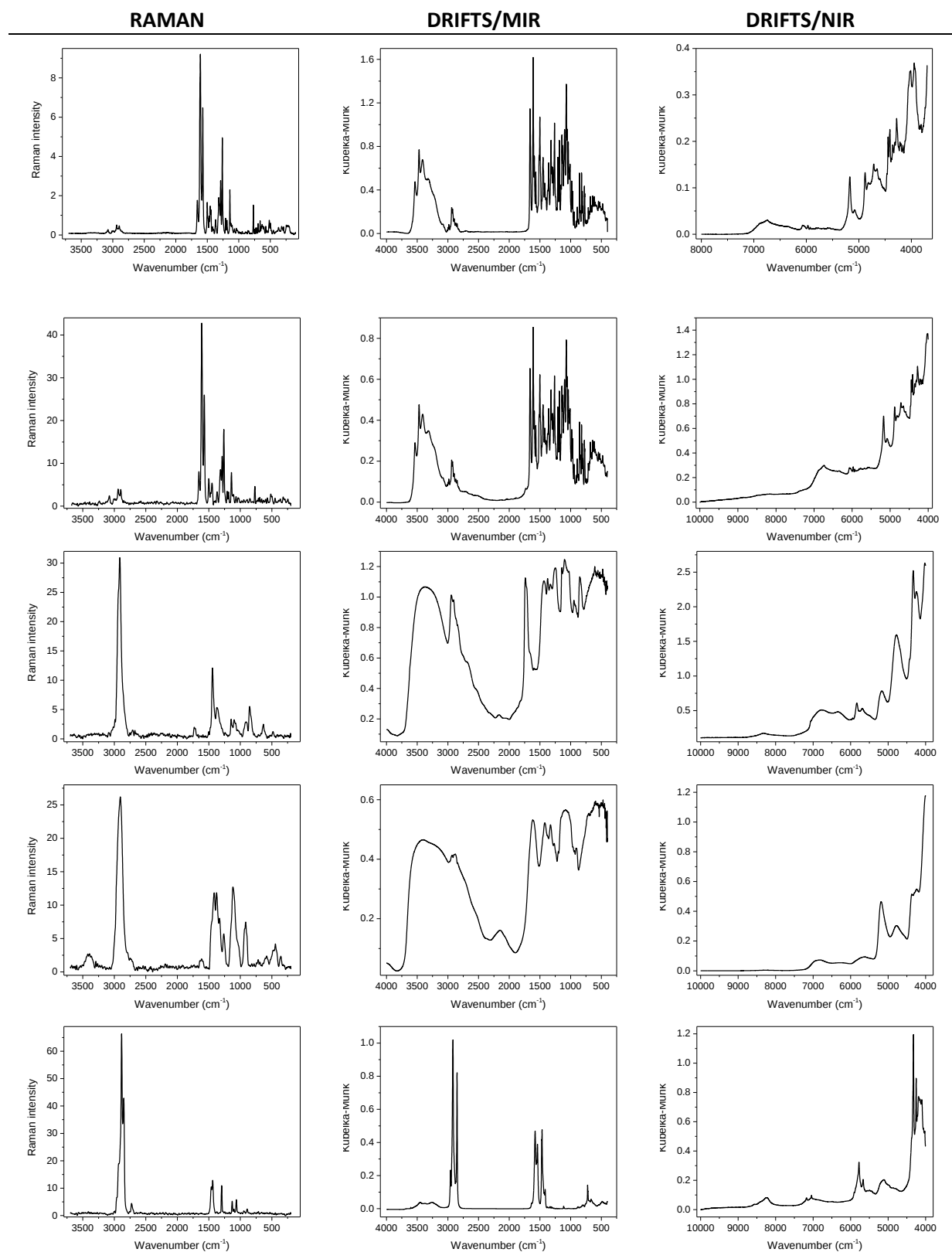


Fig. S1 Raman, MIR and NIR spectra of Preparation 1, diosmin hydrate, polyvinyl alcohol, croscarmellose sodium and magnesium stearate; from the top

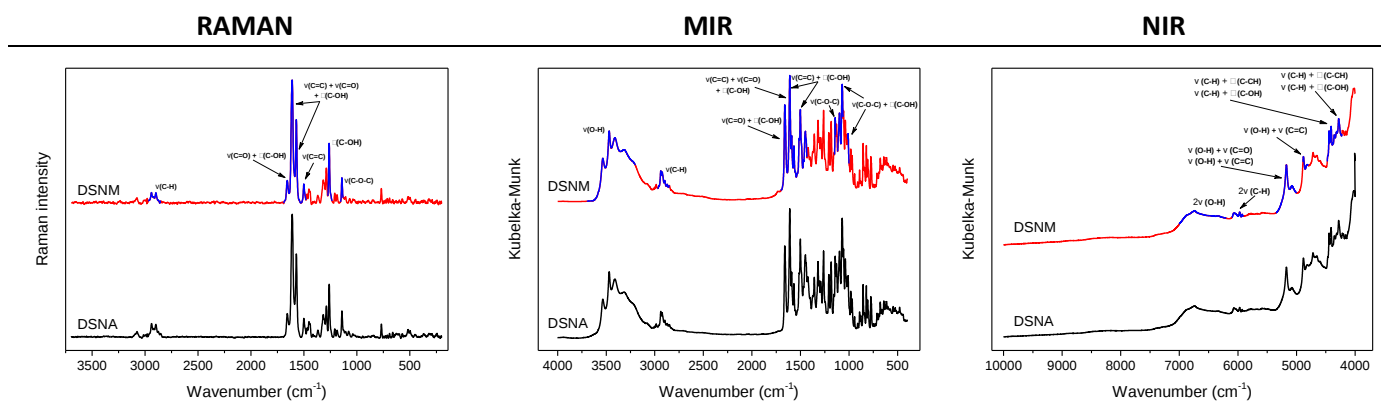


Fig. S2 Experimental Raman, MIR and NIR spectra of hydrated (DSNM) and anhydrous (DSNA) diosmin

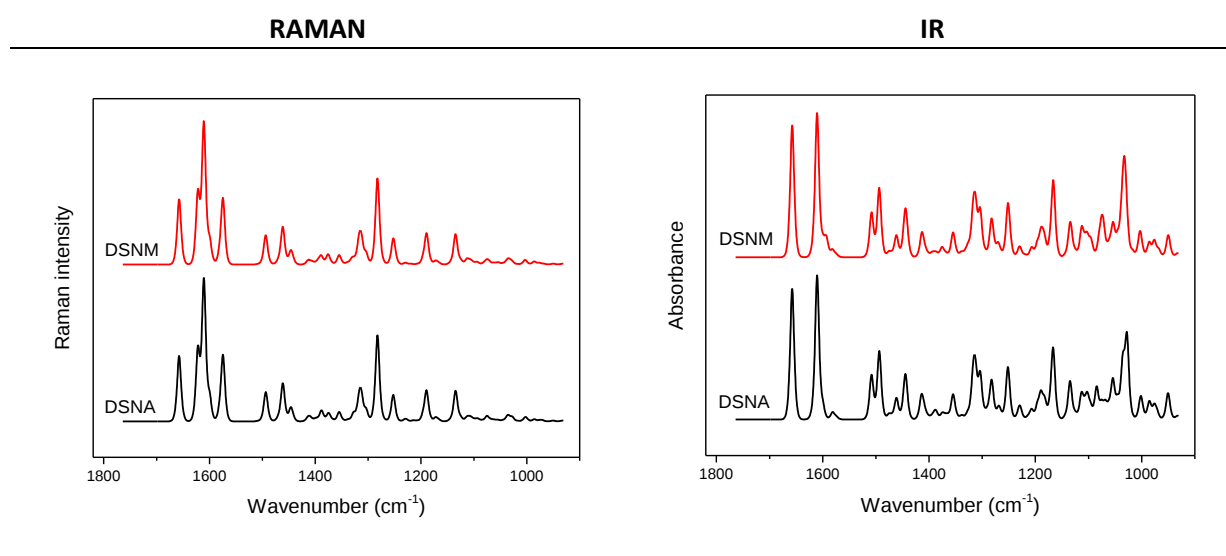


Fig. S3 Calculated Raman and IR spectra of hydrated (DSNM) and anhydrous (DSNA) diosmin; abscissa scale multiplied by a factor of 0.98; Gauss Lorentz profile with a half width of 8.9 cm^{-1} was used to obtain calculated spectra

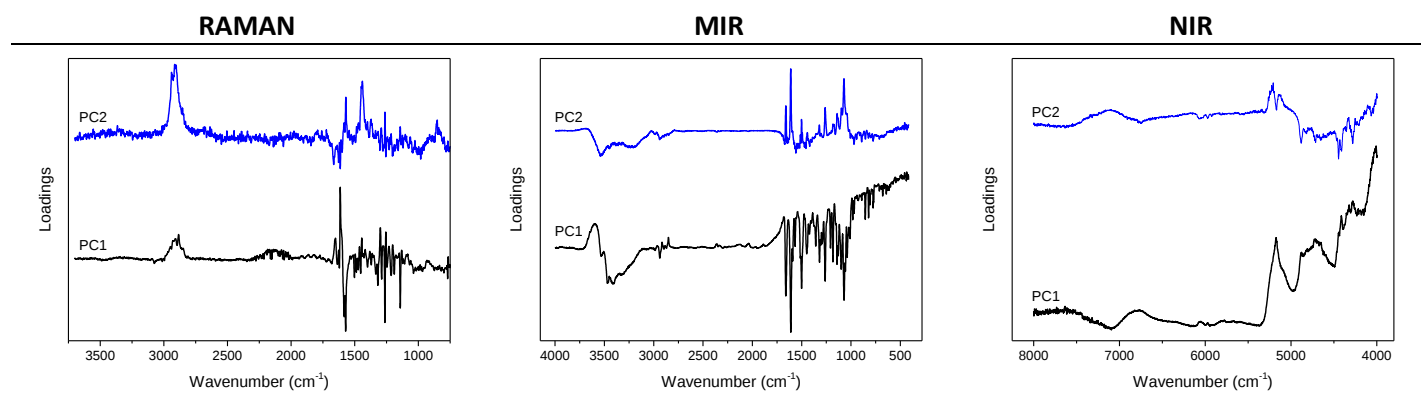


Fig.S4 Loadings plots of PCA models obtained on the basis of Raman, DRIFTS/MIR and DRIFTS/NIR spectra of calibration samples

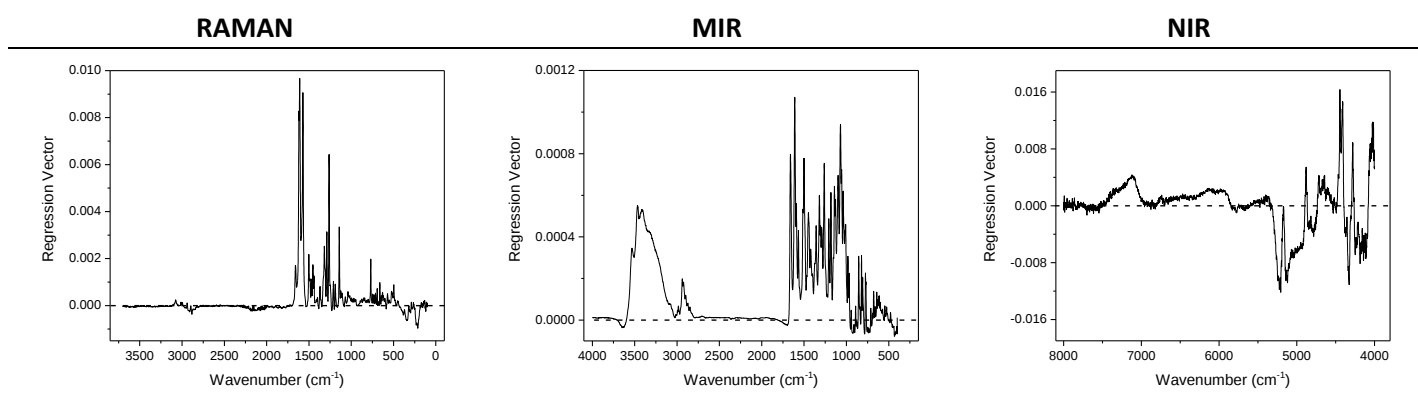


Fig. S5 Regression vectors obtained on the basis of Raman, MIR and NIR spectra of calibration samples

Tab. S1 Basic data on the analyzed preparations

Preparation	Composition of the tablet core	Declared active substance content	
		[mg/tablet]	[mf]
Preparation 1	Polyvinyl alcohol, croscarmellose sodium, magnesium stearate	1000	0.894
Preparation 2	Microcrystalline cellulose, lactose monohydrate, croscarmellose sodium, colloidal silica, magnesium stearate	1000	0.686
Preparation 3	Polyvinyl alcohol, croscarmellose sodium, magnesium stearate, talcum, colloidal anhydrous silica	1000	0.853
Preparation 4	Microcrystalline cellulose, talc, colloidal anhydrous silica, stearic acid, povidone, sodium dodecyl sulfate	500	0.653
Preparation 5	Microcrystalline cellulose, sodium carboxymethyl starch, magnesium stearate	500	0.783
Preparation 6	Polyvinyl alcohol, croscarmellose sodium, talc, colloidal anhydrous silica, magnesium stearate	1000	0.868
Preparation 7	Corn starch, microcrystalline cellulose, magnesium stearate, povidone	600	0.834
Preparation 8	Sodium carboxymethyl starch, microcrystalline cellulose, gelatin, talc, magnesium stearate	500	0.696

mf- mass fraction

Tab. S2 Composition of calibration samples [mf]

No	Diosmin	Magnesium stearate	Polyvinyl alcohol	Croscarmellose sodium
1	0.841	0.019	0.070	0.071
2	0.844	0.018	0.082	0.056
3	0.848	0.012	0.077	0.064
4	0.852	0.032	0.053	0.063
5	0.858	0.035	0.044	0.063
6	0.862	0.017	0.066	0.055
7	0.864	0.029	0.072	0.035
8	0.865	0.027	0.082	0.026
9	0.867	0.025	0.061	0.047
10	0.868	0.016	0.065	0.050
11	0.873	0.020	0.080	0.028
12	0.875	0.018	0.078	0.029
13	0.878	0.031	0.075	0.017
14	0.880	0.019	0.079	0.022
15	0.880	0.018	0.069	0.033
16	0.884	0.017	0.075	0.024
17	0.887	0.027	0.050	0.036
18	0.890	0.011	0.078	0.020
19	0.894	0.006	0.028	0.073
20	0.894	0.022	0.046	0.038
21	0.898	0.026	0.016	0.060
22	0.903	0.010	0.064	0.022
23	0.904	0.019	0.060	0.017
24	0.908	0.010	0.044	0.039
25	0.914	0.012	0.032	0.042
26	0.919	0.025	0.021	0.035
27	0.926	0.028	0.017	0.028
28	0.668	0.033	0.124	0.175
29	0.640	0.028	0.195	0.138
30	0.720	0.041	0.188	0.051
31	0.695	0.025	0.093	0.187
32	0.662	0.036	0.103	0.199
33	0.684	0.023	0.091	0.202
34	0.717	0.027	0.065	0.190
35	0.733	0.045	0.141	0.080
36	0.720	0.013	0.164	0.103
37	0.614	0.054	0.160	0.172
38	0.718	0.029	0.176	0.077
39	0.734	0.042	0.078	0.147
40	0.790	0.023	0.159	0.028
41	0.603	0.034	0.222	0.141
42	0.732	0.036	0.082	0.150
43	0.749	0.042	0.125	0.084
44	0.610	0.019	0.186	0.184
45	0.784	0.012	0.174	0.030
46	0.710	0.045	0.167	0.078
47	0.728	0.009	0.124	0.140
48	0.836	0.047	0.059	0.058

49	0.725	0.038	0.050	0.187
50	0.749	0.013	0.050	0.188
51	0.740	0.051	0.085	0.123
52	0.704	0.038	0.099	0.158
53	0.774	0.034	0.096	0.096
54	0.727	0.005	0.129	0.139
55	0.763	0.047	0.036	0.154
56	0.712	0.050	0.062	0.176
57	0.732	0.038	0.032	0.198
58	0.608	0.028	0.196	0.168
59	0.830	0.038	0.097	0.034
60	0.702	0.051	0.179	0.068
61	0.716	0.028	0.174	0.082
62	0.763	0.050	0.144	0.043
63	0.732	0.021	0.177	0.070
64	0.652	0.029	0.172	0.148
65	0.704	0.040	0.183	0.073
66	0.737	0.025	0.081	0.158
67	0.791	0.020	0.047	0.142
68	0.708	0.042	0.158	0.093
69	0.713	0.007	0.159	0.122
70	0.734	0.016	0.095	0.156
71	0.747	0.039	0.098	0.116
72	0.754	0.022	0.080	0.144
73	0.762	0.039	0.109	0.091
74	0.774	0.011	0.124	0.091
75	0.786	0.044	0.085	0.086
76	0.791	0.032	0.055	0.122
77	0.828	0.017	0.091	0.064
78	0.839	0.016	0.082	0.063
79	0.794	0.010	0.047	0.149
80	0.802	0.023	0.093	0.082
81	0.810	0.041	0.071	0.077
82	0.825	0.013	0.098	0.064
83	0.836	0.014	0.064	0.086

mf- mass fraction

Tab. S3 API content in the studied preparations [mf]

Preparation	Diosmin		Hesperidin
	Declared	Determined by HPLC	
<i>Preparation 1</i>	0.894	0.902 ± 0.002	0.032 ± 0.001
<i>Preparation 2</i>	0.686	0.715 ± 0.003	0.024 ± 0.000
<i>Preparation 3</i>	0.853	0.918 ± 0.004	0.021 ± 0.001
<i>Preparation 4</i>	0.653	0.662 ± 0.001	0.035 ± 0.000
<i>Preparation 5</i>	0.783	0.791 ± 0.002	0.037 ± 0.001
<i>Preparation 6</i>	0.868	0.907 ± 0.002	0.021 ± 0.000
<i>Preparation 7</i>	0.834	0.811 ± 0.003	0.014 ± 0.001
<i>Preparation 8</i>	0.696	0.726 ± 0.001	0.030 ± 0.000

Tab. S4 Band assignment in the Raman and MIR spectra of diosmin

Band position [cm ⁻¹]		
RAMAN	MIR	Assignment
-	3535	ν(O-H)
-	3469	ν(O-H)
-	3411	ν(O-H)
-	3318	ν(O-H)
2940	2939	ν(CH ₃)
2920	2924	ν(C-H)
2897	2897	ν(C-H)
2851	2849	ν(C-H)
1657	1661	ν(C=O), δ(C-OH)
1611	1611	ν(C=C), δ(C-OH)
-	1594	δ(H-OH) _{water}
1572	1567	ν(C=C), δ(C-OH)
-	1514	ν(C=C), δ(CC-H)
1501	1501	ν(C=C), δ(CC-H), δ(C-OH)
1470	1470	δ(CH ₃)
1453	1449	δ(CH ₃)
1443	1442	δ(CH ₃)
1369	-	δ(CC-H), δ(C-OH)
-	1356	δ(CC-H), δ(C-OH)
1318	1320	δ(CC-H)
1309	1306	δ(CC-H)
1289	1293	δ(C-OH), δ(CC-H)
1262	1262	δ(C-OH), δ(CC-H)
1209	1209	δ(C-OH), δ(CC-H), δ(CH ₃)
1190	1184	δ(C-OH), δ(CC-H)
1142	1142	ν(C-O-C), δ(C-OH)
-	1098	ν(C-O-C), ν(C-OH), δ(C-OH)
1079	1074	ν(C-O-C), ν(C-OH), δ(C-OH)
-	1004	ν(C-C), ν(C-OH), ν(C-O)
769	770	δ(C-OH)

Tab. S5 Parameters of PLS models for preparations 2-8

<i>Preparation 2</i>			
PARAMETER	RAMAN	DRIFTS / MIR	DRIFTS / NIR
R _{cal}	0.9856	0.9738	0.9840
R _{test}	0.9777	0.9748	0.9723
R _{cv}	0.9543	0.9554	0.9532
RSEP _{cal}	1.76	2.07	1.77
RSEP _{test}	2.04	2.11	2.03
Number of PLS factors	5	5	6
Wavenumber range [cm ⁻¹]	680-790	1046-1119	3802-4778
	1051-1640	1167-1196	
	3037-3127	1547-1639	
		2636-3118	
Normalization	None	SNV	None

<i>Preparation 3</i>			
PARAMETER	RAMAN	DRIFTS / MIR	DRIFTS / NIR
R _{cal}	0.9827	0.9680	0.9912
R _{test}	0.9767	0.9627	0.9883
R _{cv}	0.9442	0.9544	0.9535
RSEP _{cal}	1.85	2.37	1.22
RSEP _{test}	2.16	2.44	1.29
Number of PLS factors	5	5	6
Wavenumber range [cm ⁻¹]	959-1640	1490-1635	4141-4919
	3035-3122	2636-3094	
Normalization	SNV	MSC	MSC

<i>Preparation 4</i>			
PARAMETER	RAMAN	DRIFTS / MIR	DRIFTS / NIR
R _{cal}	0.9955	0.9750	0.9905
R _{test}	0.9935	0.9726	0.9837
R _{cv}	0.9507	0.9612	0.9618
RSEP _{cal}	0.98	2.09	1.32
RSEP _{test}	1.12	2.00	1.55
Number of PLS factors	6	5	7
Wavenumber range [cm ⁻¹]	486-752	503-533	3811-3936
	1054-1528	868-928	4379-4761
	2636-3150	1168-1195	6153-6683
		1546-1634	
		2563-3027	
Normalization	SNV	MSC	SNV

<i>Preparation 5</i>			
PARAMETER	RAMAN	DRIFTS / MIR	DRIFTS / NIR
R _{cal}	0.9913	0.9782	0.9844
R _{test}	0.9756	0.9666	0.9783
R _{cv}	0.9627	0.9610	0.9616
RSEP _{cal}	1.34	1.97	1.73
RSEP _{test}	1.39	2.21	1.82
Number of PLS factors	5	6	6
Wavenumber range [cm ⁻¹]	486-910	1232-1390	3729-3910
	1221-1529	1390-1632	4232-4430
	3042-3125	2394-3471	5409-6624
Normalization	SNV	SNV	SNV

<i>Preparation 6</i>			
PARAMETER	RAMAN	DRIFTS / MIR	DRIFTS / NIR
R _{cal}	0.9842	0.9919	0.9754
R _{test}	0.9719	0.9857	0.9767
R _{cv}	0.9533	0.9545	0.9552
RSEP _{cal}	1.76	1.17	2.1
RSEP _{test}	2.33	1.57	2.0
Number of PLS factors	5	6	6
Wavenumber range [cm ⁻¹]	959-1633	951-1046	3741-3911
	3035-3121	1085-1117	4141-4436
		1547-1631	4533-5117
		3026-3698	5756-6145
Normalization	MSC	MSC	SNV

<i>Preparation 7</i>			
PARAMETER	RAMAN	DRIFTS / MIR	DRIFTS / NIR
R _{cal}	0.9947	0.9683	0.9917
R _{test}	0.9881	0.9645	0.9806
R _{cv}	0.9582	0.9539	0.9626
RSEP _{cal}	1.05	2.36	1.23
RSEP _{test}	1.39	2.38	1.68
Number of PLS factors	6	5	7
Wavenumber range [cm ⁻¹]	486-910	1494-1635	3811-3967
	1275-1479	2636-3094	4379-4762
	3042-3121		6153-6683
Normalization	SNV	MSC	SNV

PARAMETER	<i>Preparation 8</i>		
	RAMAN	DRIFTS / MIR	DRIFTS / NIR
R _{cal}	0.9913	0.9785	0.9842
R _{test}	0.9756	0.9727	0.9761
R _{cv}	0.9627	0.9576	0.9630
RSEP _{cal}	1.34	1.96	1.75
RSEP _{test}	1.39	2.01	1.79
Number of PLS factors	5	6	6
Wavenumber range [cm ⁻¹]	486-910	1232-1390	3729-3910
	1221-1529	1390-1632	4232-4463
	3042-3125	2394-3726	5409-6624
Normalization	SNV	SNV	SNV

R- correlation coefficient , R_{cv}- correlation coefficient of crossvalidation, cal - calibration samples set, test – test samples set
 SNV- standard normal variate, MSC- multiplicative scatter correction

Tab. S6 Diosmin recovery [%] (n=10)

Preparation	RAMAN	DRIFTS / MIR	DRIFTS / NIR
<i>Preparation 1</i>	99.75 ± 1.88	100.35 ± 1.42	99.91 ± 3.20
<i>Preparation 2</i>	99.45 ± 1.53	100.37 ± 1.04	100.49 ± 1.89
<i>Preparation 3</i>	99.71 ± 0.95	99.80 ± 1.64	100.02 ± 0.58
<i>Preparation 4</i>	99.95 ± 1.17	100.55 ± 0.87	100.25 ± 1.09
<i>Preparation 5</i>	100.36 ± 1.95	100.19 ± 2.83	100.41 ± 1.25
<i>Preparation 6</i>	99.79 ± 0.61	99.92 ± 3.40	99.84 ± 0.82
<i>Preparation 7</i>	100.27 ± 2.50	100.03 ± 2.69	100.00 ± 1.56
<i>Preparation 8</i>	100.26 ± 1.67	100.23 ± 1.57	99.96 ± 1.60