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Journal of Chromatography A, 990 (2003) 63–73
JOURNAL OF CHROMATOGRAPHY A
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Electrophoretic enantiomer separations at high pH using the new, single-isomer octakis(2,3-dimethyl-6-*O*-sulfo)-γ-cyclodextrin as chiral resolving agent

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Abstract

The latest, single-isomer, sulfated γ-cyclodextrin, the sodium salt of octakis(2,3-dimethyl-6-*O*-sulfo)-γ-cyclodextrin that is stable in basic media was used to separate the enantiomers of neutral, weak acid and weak base analytes by capillary electrophoresis in high pH aqueous background electrolytes. The effective mobilities and separation selectivities were found to follow trends similar to those observed earlier in acidic aqueous background electrolytes. Octakis(2,3-dimethyl-6-*O*-sulfo)-γ-cyclodextrin proved to interact with all three analyte types less strongly than other single-isomer sulfated cyclodextrins do under comparable conditions.

Keywords: Enantiomer separation; Cyclodextrins; Sulfated cyclodextrins; Octakis(2,3-dimethyl-6-*O*-sulfo)-γ-cyclodextrin

1. Introduction

Reviews in the latest special issue of Electrophoresis dedicated to the capillary electrophoretic (CE) separation of enantiomers [1,2] show that single-isomer sulfated cyclodextrins (CDs) play a unique role among the most frequently used chiral resolving agents because, in addition to affording excellent separations, they facilitate fundamental physicochemical studies. With the recent synthesis [3] of the sodium salt of octakis(2,3-dimethyl-6-*O*-sulfo)-γ-cyclodextrin (ODMS), there are now two families of single-isomer, sulfated cyclodextrins with isomeric purities greater than 95 mol%, a β-CD family and a γ-CD family, whose primary hydroxy groups on the 6-C atoms of the respective glucopyranose subunits have been completely sulfated, while their secondary hydroxy groups on the 2- and 3-carbon atoms were kept unchanged [4,5] or modified with acetyl groups [6,7] and methyl groups [3,8]. All of these single-isomer, sulfated CDs have been successfully used [3–9] in acidic background electrolytes (BGEs). However, due to their base stability, the single-isomer, sulfated CDs that carry hydroxy and methyl groups can also be used in high pH BGEs to probe additional separation selectivities [3,5,10–12]. This paper presents our first results with the latest, base-stable, single-isomer, sulfated CD, ODMS, in pH 9.5 aqueous BGEs for the CE separation of the enantiomers of neutral, weak acid and weak base analytes.

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0021-9673/02/$ – see front matter
doi:10.1016/S0021-9673(02)01797-1

2. Experimental

The chemicals used for the preparation of the BGEs, ethanolamine and methanesulfonic acid (MSA), were purchased from Aldrich (Milwaukee, WI, USA), while ODMS was synthesized and analytically characterized in our laboratory [3] and is now commercially available [13] from Antek (Houston, TX, USA). All chiral analytes listed in Fig. 1 were obtained from either Aldrich, Sigma (St. Louis, MO, USA), Wiley Organics (Coshocton, OH, USA) or Research Diagnostics (Rockdale, MD, USA). Dimethylsulfoxide (DMSO) was purchased from EM Science (Gibbstown, NJ, USA). All solutions were prepared with Milli-Q water (Millipore, Milford, MA, USA). The stock buffer was 20 m*M* ethanolamine titrated to pH 9.5 with MSA. The stock buffer was used to dissolve the calculated amounts of ODMS to obtain the 5–40 m*M* ODMS BGEs. Samples were dissolved in the respective BGEs at an approximate concentration of 0.5 m*M*.

The enantiomer separations were obtained with a P/ACE 5000 CE system (Beckman-Coulter, Fullerton, CA, USA). Its variable wavelength UV detector was operated at 214 nm, its thermostat at 20 °C. All separations were carried out on uncoated, fused-silica capillaries with an I.D. of 25 μm, an O.D. of 150 μm, a total length, L_t, of 46 cm, and an injector-to-detector length, L_d, of 39 cm (Polymicro Technologies, Phoenix, AZ, USA). The samples were pressure injected in triplicate with 1 p.s.i. nitrogen for 1 s (1 p.s.i.=6894.76 Pa). The external mobility marker method [14] indicated that DMSO did not appreciably complex with ODMS. Thus, DMSO could be used as electroosmotic flow (EOF) marker and was co-injected with each sample to determine the actual electroosmotic flow mobility, μ_{EOF}.

In order to obtain meaningful effective electrophoretic mobility values, all measurements were made within the linear region of the respective Ohm's plots: power dissipation was maintained by varying the applied potential (U_{appl}) between 7 and 12 kV. The effective mobilities of the enantiomers (μ_1^{eff} and μ_2^{eff}) were obtained as $\mu_1^{eff}=\mu_1^{obs}-\mu_{EOF}$, the separation selectivities, α, as $\alpha=\mu_1^{eff}/\mu_2^{eff}$ (where subscript 2 arbitrarily refers to the enantiomer whose effective mobility in the 5 m*M* ODMS BGE was smaller), and the normalized electroosmotic flow mobility values, β, as $\beta=\mu_{EOF}/\mu_2^{eff}$ [15]. Typical μ_{EOF} values decreased from $+40\cdot10^{-5}$ cm^2 V^{-1} s^{-1} to $+18\cdot10^{-5}$ cm^2 V^{-1} s^{-1} as the ODMS concentration of the BGE was increased from 5 to 40 m*M*.

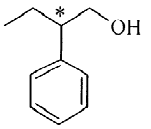
3. Results and discussion

ODMS was used for the CE separation of the enantiomers of 65 neutral, weak acid and weak base analytes whose structures are shown in Fig. 1. The effective mobilities, μ (in 10^{-5} cm^2 V^{-1} s^{-1} units), the separation selectivities, α, the measured peak resolution values, R_s, the corresponding dimensionless EOF mobility values, β, and the injector-to-detector effective potential drop values, U ($U=U_{appl}L_d/L_t$, in kV units), for the neutral, weak acid and weak base enantiomers are listed in Tables 1–3, respectively. When a mobility value could not be measured (due to interference by a system peak or DMSO), the tables list NA (not available).

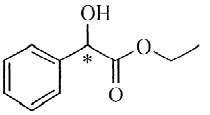
For the neutral analytes tested, the anionic effective mobilities increased very slightly, in the 0 to −2.6 mobility unit range, as the ODMS concentration was increased from 5 to 40 m*M* (Table 1). This indicates that interactions between typical neutral analytes and ODMS are much weaker than what were observed with the other single-isomer 6-*O*-sulfo CDs [3–12].

For the weak acid analytes tested, the anionic effective mobilities are higher at low ODMS concentrations and become lower as the ODMS concentration is increased. This phenomenon is due to the interplay of their increasing complexation with ODMS and the mobility suppressing effects of the increasing ionic strength of the BGE [16]. Separation selectivities were generally closer to unity than those obtained at low pH for the same analytes [3] indicating that weak acid enantiomers and ODMS follow mostly desionoselective separation patterns [15]. The only exception is fenoprofen, for which $\alpha=1.02$, and baseline resolution could be obtained at 40 m*M* ODMS.

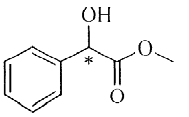
For weak bases, the effective mobility patterns are similar to those observed in the low pH BGEs [3] indicating that pH 9.5 is not high enough to render most of the weak base analytes tested neutral. The



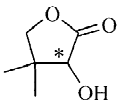
N02: 2-Phenylbutanol



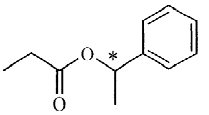
N10: Ethylmandelate



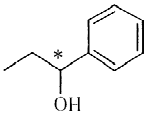
N15: Methylmandelate



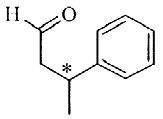
N19: Pantolactone



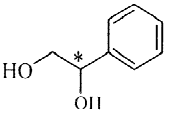
N20: 1-Phenylcthylpropionate



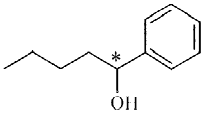
N21: 1-Phenybutanol



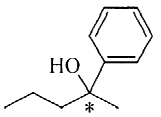
N22: 3-Phenylbutyraldehyde



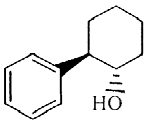
N24: Styrene glycol



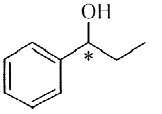
N25: 1-Phenylpentanol



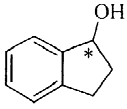
N26: 2-Phenyl-2-pentanol



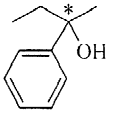
N30: trans-2-Phenyl-1-cyclohexanol



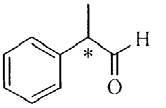
N34: 1-Phenylpropanol



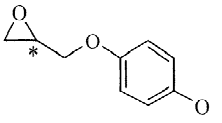
N36: 1-Indanol



N38: 2-Phenyl-2-butanol

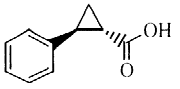


N39: 2-Phenylpropionaldehyde

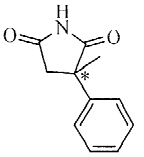


N40: 2,3-Epoxypropyl-4-methoxyphenylether

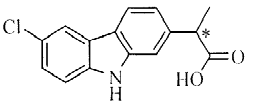
Fig. 1. Structures of the neutral, weak acid and weak base enantiomers used in this study.



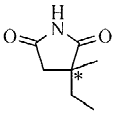
A02: trans-2-Phenyl-1-cyclopropane carboxylic acid



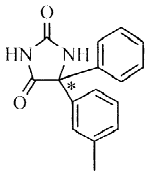
A03:α-Methyl-α-phenylsuccinimide



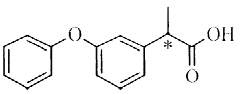
A04: Carprofen



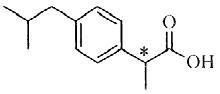
A09: Ethosuximide



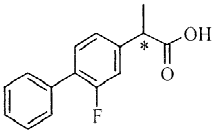
A16: 5-(4-methylphenyl)-5-phenylhydantoin



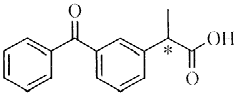
A22: Fenoprofen



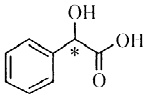
A23: Ibuprofen



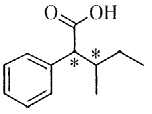
A26: Flurbiprofen



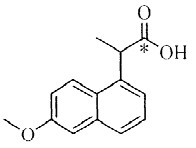
A27: Ketoprofen



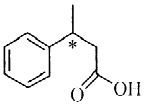
A28: Mandelic acid



A30: 2-phenyl-3-methylvaleric acid (R,R),(R,S),(S,R),(S,S)



A31: Naproxen



A36: 2-Phenylpropionic acid

Fig. 1. (*continued*)

weak bases tested here can be divided into two major groups: the first is the group of weakly binding weak bases whose effective mobilities remain cationic over the entire 5–40 m*M* ODMS concentration range, the second is the group of strongly binding weak bases whose effective mobilities become anionic at relatively low ODMS concentrations and pass (or approach) shallow anionic mobility maxima as the ODMS concentration is increased. This effective mobility pattern is again the result of the interplay between the increasing degree of complexation and the differential depression of the mobilities of the

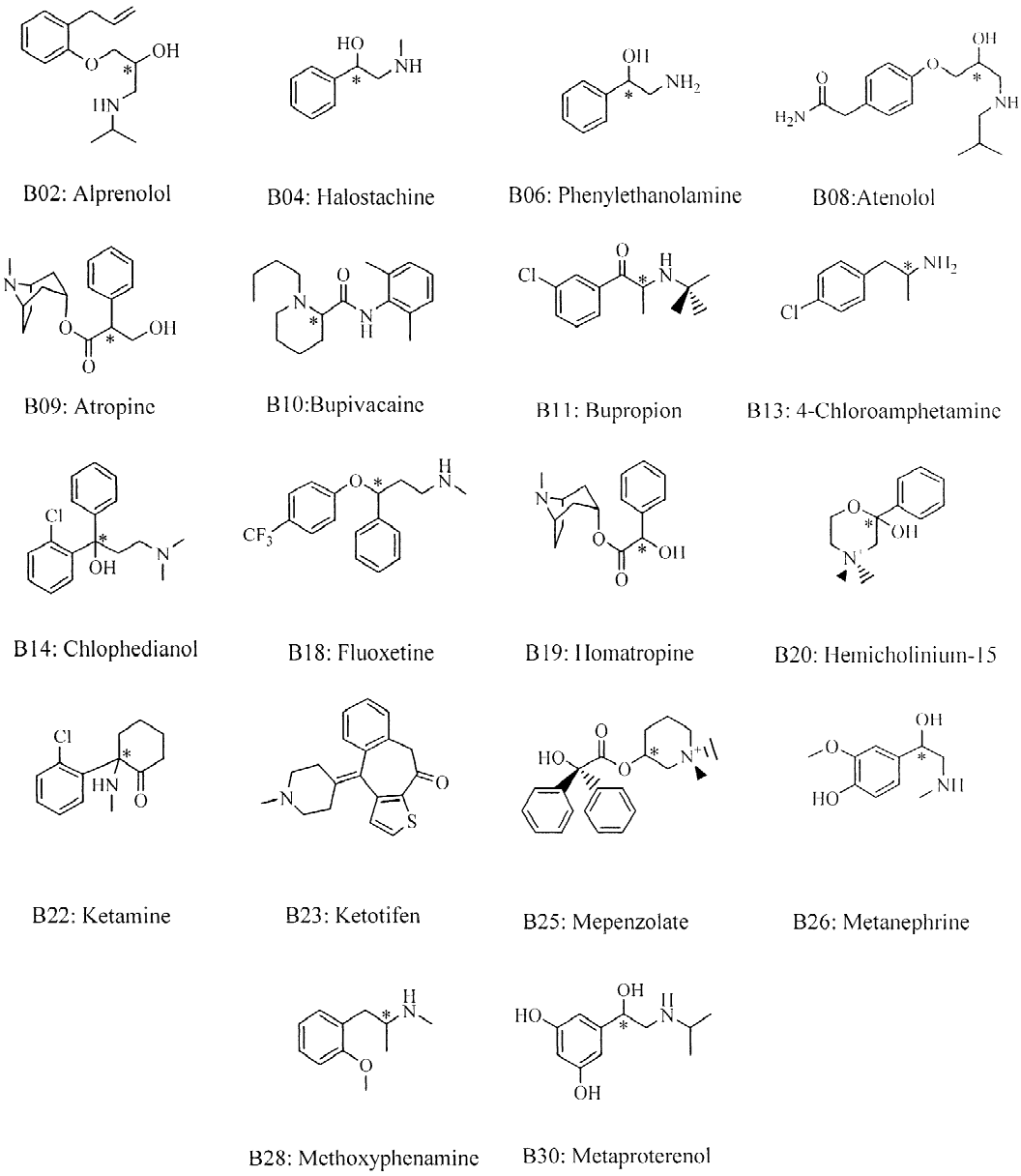
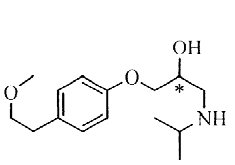


Fig. 1. (*continued*)

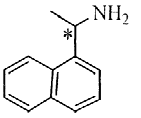
free and complexed forms of the weak base analyte by the increasing ionic strength of the BGEs. Favorable separation selectivities were found only for 14 of the 36 weak bases tested, fewer than in the low pH BGEs [3].

However, diltiazem could only be separated in the high pH BGE, indicating that the diltiazem-ODMS system follows a desionoselective separation pattern [15].

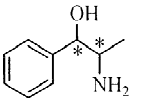
Representative electropherograms obtained in the high pH BGEs for some of the analytes are shown in Figs. 2 and 3. The numbers next to the compound codes (Fig. 1) indicate the ODMS concentrations and the applied potentials used.



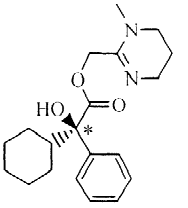
B31: Metoprolol



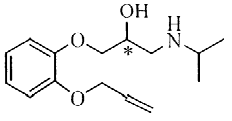
B33: (1-Napthyl)ethylamine



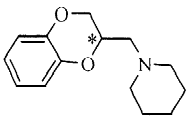
B34: Norephedrine (1R,2S) & (1S,2R)



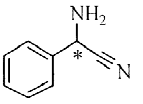
B36: Oxyphencyclimine



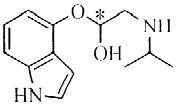
B37: Oxprenolol



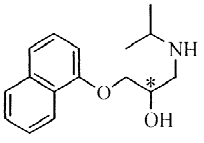
B38: Piperoxan



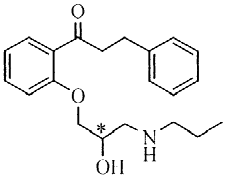
B39: Phenylglycinonitrile



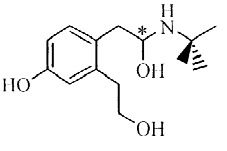
B41: Pindolol



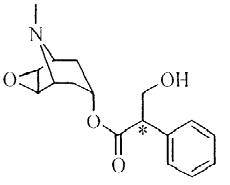
B42: Propranolol



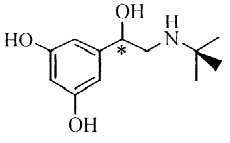
B43: Propafenone



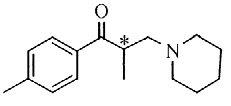
B45: Salbutamol



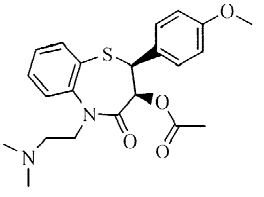
B46: Scopolamine



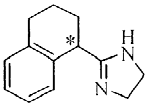
B47: Terbutaline



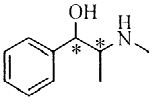
B51: Tolperisone



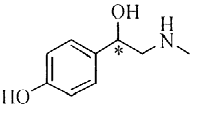
B57: Diltiazem



B58: Tetrahydrozoline



B60: Ephedrine (1R,2S) & (1S,2R)



B61: Synephrine

Fig. 1. (*continued*)

4. Conclusions

The use of the new, single-isomer, base-stable, sulfated γ-CD, the sodium salt of octakis(2,3-di-methyl-6-*O*-sulfo)-γ-cyclodextrin has been studied in high pH BGEs. Interactions between ODMS and

Table 1
Effective mobilities of the less mobile enantiomer (μ, in 10^{-5} cm^2 V^{-1} s^{-1}units), separation selectivities (α), measured peak resolution values (R_s), dimensionless EOF mobility values (β) and the injector-to-detector effective potential drop (U) in pH 9.5 ODMS BGEs for nonionic analytes

Analyte	0 m*M* ODMS U=10.2 kV	5 m*M* ODMS U=8.5 kV				10 m*M* ODMS U=6.8 kV				20 m*M* ODMS U=6.8 kV				30 m*M* ODMS U=5.9 kV				40 m*M* ODMS U=7.6 kV			
	μ	μ	α	β	R_s	μ	α	β	R_s	μ	α	β	R_s	μ	α	β	R_s	μ	α	β	R_s
N02	0	−0.3	1.0	−151	0	−0.7	1.00	−60	0.0	−1.0	1.18	−30	0.6	−1.5	1.19	−13	1.3	−1.8	1.19	−10	1.9
N10	0	NA				−0.4	1.00	−103	0.0	−0.6	1.00	−47	0.0	−1.1	1.00	−18	0.0	−1.2	1.07	−15	<0.5
N15	0	NA				NA				−0.6	1.00	−47	0.0	−1.0	1.00	−18	0.0	−1.2	1.00	−14	0.0
N19	0	NA				NA				NA				−0.3	1.00	−68	0.0	−0.4	1.00	−45	0.0
N20	0	NA				−0.7	1.00	−55	0.0	−1.2	1.00	−25	0.0	−2.1	1.00	−9	0.0	−2.1	1.00	−8	0.0
N21	0	−0.4	1.0	−127	0	−0.8	1.00	−52	0.0	−1.1	1.00	−25	0.0	−1.9	1.00	−9	0.0	−2.1	1.00	−8	0.0
N22	0	NA				NA				−0.9	1.00	−31	0.0	−1.5	1.05	−16	<0.5	−1.6	1.07	−14	0.5
N24	0	NA				−0.4	1.00	−110	0.0	−0.5	1.00	−56	0.0	−0.9	1.00	−17	0.0	−1.0	1.00	−22	0.0
N25	0	−0.4	1.0	−118	0	−0.8	1.00	−48	0.0	−1.2	1.00	−24	0.0	−2.1	1.00	−12	0.0	−2.2	1.00	−10	0.0
N26	0	−0.3	1.0	−155	0	−0.7	1.00	−61	0.0	−1.0	1.00	−32	0.0	−1.6	1.00	−10	0.0	−1.7	1.00	−11	0.0
N30	0	NA				−0.8	1.32	−52	0.6	−1.2	1.34	−24	1.7	−2.2	1.35	−9	3.6	−2.3	1.34	−8	4.4
N34	0	−0.3	1.0	−150	0	−0.7	1.00	−63	0.0	−1.0	1.00	−29	0.0	−1.8	1.00	−9	0.0	−1.9	1.00	−10	0.0
N36	0	−0.4	1.0	−134	0	−0.7	1.00	−61	0.0	−1.0	1.00	−28	0.0	−1.7	1.00	−10	0.0	−1.9	1.00	−10	0.0
N38	0	−0.3	1.0	−134	0	−0.6	1.00	−61	0.0	−0.9	1.00	−28	0.0	−1.6	1.00	−10	0.0	−1.7	1.00	−10	0.0
N39	0	NA				−0.5	1.00	−71	0.0	−0.7	1.00	−32	0.0	−1.2	1.00	−12	0.0	−1.4	1.00	−11	0.0
N40	0	NA				−1.0	1.00	−87	0.0	−1.5	1.00	−41	0.0	−2.6	1.00	−17	0.0	−2.6	1.00	−14	0.0

Table 2
Effective mobilities of the less mobile enantiomer (μ, in 10^{-5} cm^2 V^{-1} s^{-1}units), separation selectivities (α), measured peak resolution values (R_s), dimensionless EOF mobility values (β) and the injector-to-detector effective potential drop (U) in pH 9.5 ODMS BGEs for weak acid analytes

Analyte	0 m*M* ODMS *U*=10.2 kV	5 m*M* ODMS *U*=8.5 kV				10 m*M* ODMS *U*=6.8 kV				20 m*M* ODMS *U*=6.8 kV				30 m*M* ODMS *U*=5.9 kV				40 m*M* ODMS *U*=7.6 kV			
	μ	μ	α	β	R_s	μ	α	β	R_s	μ	α	β	R_s	μ	α	β	R_s	μ	α	β	R_s
A02	−20.3	−20.3	1.00	−2.4	0.0	−18.8	1.00	−2.2	0.0	−15.6	1.00	−2.0	0.0	−16.4	1.00	−1.7	0.0	−14.0	1.00	−1.6	0.0
A03	−16.3	−14.2	1.00	−2.8	0.0	−14.4	1.00	−2.8	0.0	−14.2	1.00	−2.1	0.0	−13.7	1.00	−2.0	0.0	−11.9	1.00	−1.8	0.0
A04	−15.9	−16.7	1.00	−2.9	0.0	−15.6	1.00	−2.6	0.0	−13.7	1.00	−2.2	0.0	−14.9	1.00	−1.8	0.0	−12.9	1.00	−1.7	0.0
A09	−8.4	−10.2	1.00	−4.0	0.0	−10.4	1.00	−3.9	0.0	−11.6	1.00	−2.6	0.0	−9.4	1.00	−2.8	0.0	−10.0	1.00	−1.9	0.0
A16	−12.9	−12.5	1.00	−3.2	0.0	−13.4	1.00	−3.0	0.0	−11.7	1.00	−2.6	0.0	−11.9	1.00	−2.3	0.0	−10.5	1.00	−1.8	0.0
A22	−16.8	−16.7	1.00	−2.9	0.0	−15.5	1.00	−2.6	0.0	−13.2	1.01	−2.3	0.5	−14.0	1.01	−1.9	1.1	−12.2	1.02	−1.8	1.6
A23	−16.9	−16.6	1.00	−2.9	0.0	−15.3	1.00	−2.7	0.0	−12.6	1.00	−2.4	0.0	−13.0	1.00	−1.9	0.0	−11.1	1.00	−1.9	0.0
A26	−17.1	−16.9	1.00	−2.9	0.0	−15.8	1.00	−2.6	0.0	−13.5	1.00	−2.2	0.0	−14.1	1.00	−1.6	0.0	−12.4	1.00	−1.7	0.0
A27	−16.3	−16.0	1.00	−3.0	0.0	−14.7	1.00	−2.8	0.0	−12.4	1.00	−2.4	0.0	−13.0	1.00	−2.1	0.0	−11.1	1.00	−1.9	0.0
A28	−22.5	−20.5	1.00	−2.2	0.0	−20.6	1.00	−2.0	0.0	−16.7	1.00	−1.8	0.0	−17.3	1.00	−1.5	0.0	−14.5	1.00	−1.6	0.0
A30	−17.7	−17.0	1.01	−2.8	0.6	−16.0	1.01	−2.5	0.6	−13.0	1.01	−2.3	0.6	−13.1	1.01	−1.6	1.1	−11.4	1.01	−1.9	1.0
A31	−17.4	−17.2	1.00	−2.8	0.0	−16.3	1.00	−2.5	0.0	−13.3	1.00	−2.2	0.0	−13.7	1.00	−1.6	0.0	−11.7	1.00	−1.8	0.0
A36	−22.0	−21.0	1.00	−2.3	0.0	−19.4	1.00	−2.1	0.0	−16.0	1.00	−1.8	0.0	−16.6	1.00	−1.4	0.0	−13.9	1.00	−1.6	0.0

Table 3
Effective mobilities of the less mobile enantiomer (μ, in 10^{-5} cm^2 $V^{-1}s^{-1}$units), separation selectivities (α), measured peak resolution values (R_s), dimensionless EOF mobility values (β) and the injector-to-detector effective potential drop (U) in pH 9.5 ODMS BGEs for weak base analytes

Analyte	0 m*M* ODMS U=22.9 kV	5 m*M* ODMS U=8.5 kV				10 m*M* ODMS U=6.8 kV				20 m*M* ODMS U=6.8 kV				30 m*M* ODMS U=5.9 kV				40 m*M* ODMS U=7.6 kV			
	μ	μ	α	β	R_s	μ	α	β	R_s	μ	α	β	R_s	μ	α	β	R_s	μ	α	β	R_s
B02	11.2	4.0	1.04	12	<0.5	3.3	1.08	12	0.7	0.8	1.07	36	<0.5	NA	1.14	10	1.2	−0.1	1.00	−207	0.0
B04	14.5	7.1	1.00	6.9	0.0	5.5	1.00	7.0	0.0	3.2	1.00	9.0	0.0	3.1	1.00	9.1	0.0	2.8	1.00	6.6	0.0
B06	6.8	4.2	1.09	11	0.6	2.2	1.12	18	0.5	1.5	1.14	20	<0.5	1.2	1.18	23	0.7	1.1	1.18	17	0.6
B08	10.0	4.1	1.00	12	0.0	3.5	1.00	11	0.0	1.2	1.00	24	0.0	0.9	1.00	30	0.0	0.7	1.00	27	0.0
B09	11.3	NA				3.5	1.00	11	0.0	2.6	1.00	11	0.0	2.5	1.00	9.2	0.0	1.8	1.00	10	0.0
B10	0.7	NA				NA				−0.8	1.00	−38	0.0	−1.3	1.00	−20	0.0	−1.5	1.00	−12	0.0
B11	1.3	0.4	1.00	131	0.0	0.8	1.00	46	0.0	−0.8	1.00	−35	0.0	−1.5	1.00	−18	0.0	−1.7	1.00	−10	0.0
B13	14.8	4.4	1.14	10	1.4	3.8	1.19	10	1.6	1.7	1.34	17	1.9	1.4	1.34	19	1.9	1.3	1.31	14	1.9
B14	5.9	2.7	1.05	17	<0.5	1.2	1.27	32	0.9	0.7	1.63	40	1.9	−0.4	−1.04	−66	2.8	−1.0	0.10	−19	5.7
B18	10.7	−1.5	0.18	−30	2.5	−2.6	0.50	−15	2.5	−2.4	0.53	−12	4.3	−3.0	0.61	−7.6	4.6	−2.7	0.65	−6.6	3.4
B19	11.2	4.8	1.00	9.6	0.0	3.3	1.00	12	0.0	2.7	1.00	11	0.0	2.9	1.00	8.6	0.0	2.1	1.00	8.5	0.0
B20	18.2	8.3	1.00	5.6	0.0	6.3	1.00	6.3	0.0	4.5	1.00	6.3	0.0	4.8	1.00	5.2	0.0	3.8	1.00	4.7	0.0
B22	0.0	NA				−0.7	1.00	−59	0.0	−1.0	1.00	−27	0.0	−1.7	1.00	−17	0.0	−2.0	1.00	−9.3	0.0
B23	1.6	−1.3	1.00	−35	0.0	−2.9	0.85	−14	1.3	−3.9	0.80	−7.2	2.9	−5.5	0.80	−4.2	5.8	−6.0	0.77	−3.1	10.3
B25	14.1	5.4	1.00	9.0	0.0	3.4	1.00	12	0.0	2.2	1.00	13	0.0	2.1	1.00	11	0.0	1.5	1.00	12	0.0
B26	4.0	0.9	1.00	56	0.0	−1.1	1.00	−36	0.0	−1.4	1.00	−20	0.0	−2.8	1.00	−10	0.0	−2.5	1.00	−7.4	0.0
B28	17.9	10.4	1.00	4.7	0.0	8.0	1.00	4.9	0.0	5.9	1.00	4.7	0.0	5.7	1.00	4.9	0.0	4.8	1.00	3.8	0.0
B30	0.0	−1.1	1.00	−45	0.0	−4.6	1.00	−8.6	0.0	−3.0	1.00	−9.5	0.0	−4.4	1.00	−5.4	0.0	−3.8	1.00	−4.9	0.0
B31	8.4	3.9	1.00	12	0.0	1.6	1.00	25	0.0	1.3	1.00	22	0.0	0.7	1.00	32	0.0	0.6	1.00	32	0.0
B33	8.2	0.7	1.00	61	0.0	NA				−1.0	0.87	−28	<0.5	−2.4	0.94	−9.4	0.5	−2.7	0.96	−7.1	0.6
B34	6.9	2.6	1.00	16	0.0	2.3	1.00	17	0.0	2.4	1.00	11	0.0	1.5	1.00	15	0.0	1.1	1.00	18	0.0
B36	25.0	12.5	1.00	3.5	0.0	12.7	1.00	3.1	0.0	NA				2.3	1.00	10	0.0	0.7	1.00	28	0.0
B37	9.3	5.4	1.00	9.0	0.0	2.7	1.00	14	0.0	2.2	1.00	15	0.0	1.3	1.00	18	0.0	0.4	1.00	44	0.0
B38	2.3	0.8	1.00	62	0.0	−1.0	0.41	−38	1.7	−1.6	0.57	−20	2.4	−2.2	0.73	−11	2.5	−2.2	0.83	−8.5	2.2
B39	0.0	NA				−0.7	1.00	−60	0.0	−1.0	1.00	−29	0.0	−1.6	1.00	−15	0.0	−1.7	1.00	−11	0.0
B41	10.8	NA				−0.4	1.00	−88	0.0	−1.1	0.72	−25	1.4	−2.1	0.87	−11	1.3	−2.2	0.91	−8.5	1.2
B42	9.7	−3.7	0.67	−13	3.3	−4.9	0.79	−8.0	3.9	−4.8	0.83	−5.8	4.0	−5.4	0.86	−4.2	4.1	−4.7	0.88	−4.0	3.9
B43	6.9	1.9	1.00	21	0.0	0.4	1.00	91	0.0	−0.5	1.00	−56	0.0	−1.5	1.00	−15	0.0	−2.2	1.00	−8.6	0.0
B45	6.0	2.6	1.00	18	0.0	0.8	1.21	49	0.5	0.6	1.35	45	0.6	NA				−1.0	0.87	−19	0.6
B46	0.2	NA				NA				−0.4	1.00	−66	0.0	−0.8	1.00	−27	0.0	−1.0	1.00	−18	0.0
B47	2.4	NA				−1.4	1.00	−29	0.0	−1.5	1.00	−19	0.0	−1.8	1.00	−12	0.0	−2.2	1.00	−8.4	0.0
B51	5.4	1.2	1.38	41	1.0	1.6	1.37	25	1.5	1.5	1.46	23	1.8	0.4	2.12	57	2.0	−0.3	1.00	−56	0.0
B57	0.4	NA				−0.8	1.00	−51	0.0	−1.5	0.87	−18	0.9	−2.2	0.87	−11	1.3	−2.4	0.88	−7.6	1.6
B58	19.2	8.3	1.04	5.0	0.8	7.3	1.06	5.5	1.0	5.4	1.06	5.2	1.0	5.0	1.06	4.9	1.1	3.9	1.06	4.7	1.1
B60	13.7	5.2	1.08	9.3	1.0	5.9	1.09	6.8	1.2	4.7	1.10	5.9	1.4	3.2	1.12	7.7	1.3	3.4	1.13	5.5	1.7
B61	3.5	NA				0.7	1.00	58	0.0	0.3	1.00	105	0.0	−2.2	1.00	−11	0.0	−0.8	1.00	−22	0.0

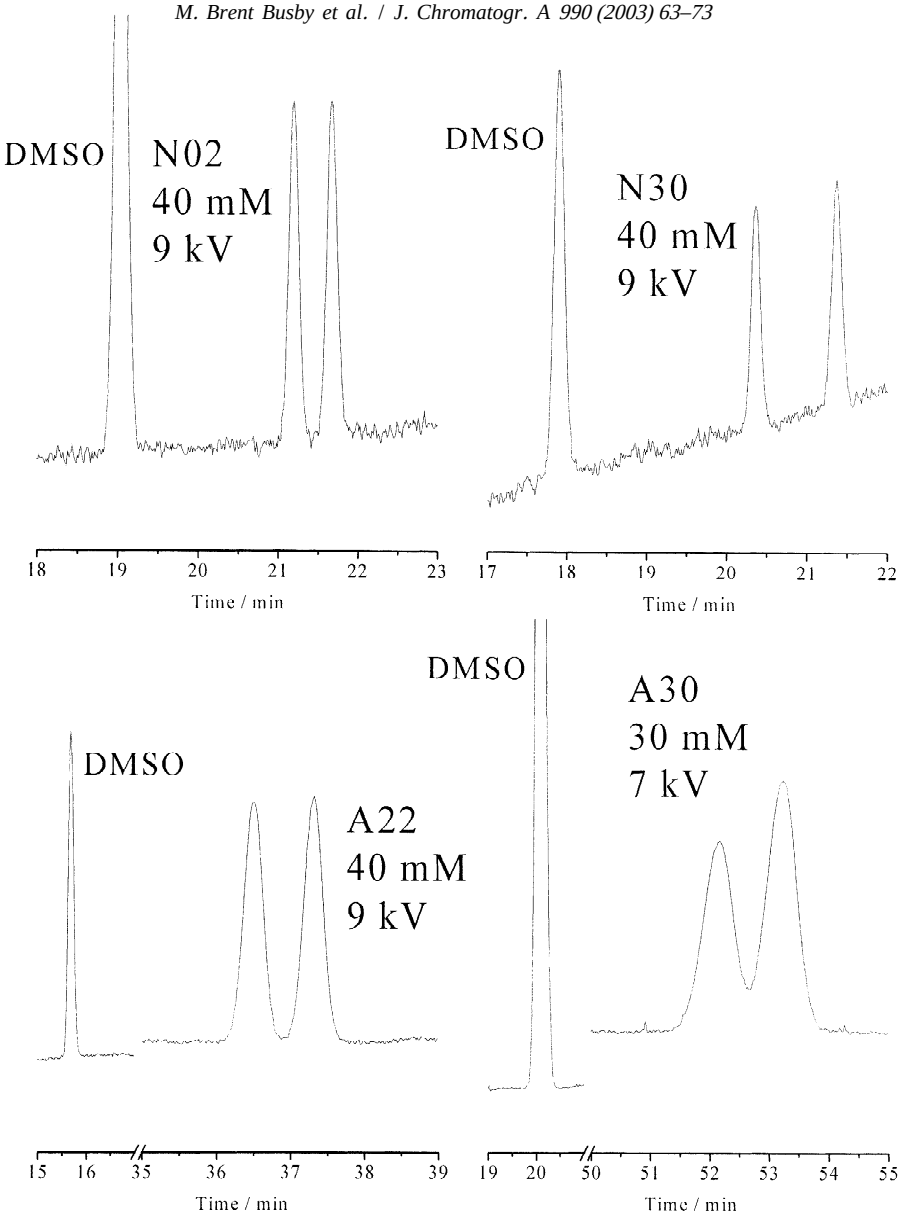


Fig. 2. Typical electropherograms of neutral and weak acid analyte enantiomers. The numbers next to the compound codes (see Fig. 1) indicate the ODMS concentrations (m*M*) and applied potentials (kV) used. Capillary: 25 μm I.D., 39/46 cm effective/total length, uncoated, fused-silica. Other conditions see Experimental.

many of the analytes studied were weaker than those observed with the other single-isomer, 6-*O*-sulfo CDs. Also, ODMS interacted with most of the analytes less strongly in the high pH BGE than it did in low pH BGEs. The enantiomers of several weak acids and one weak base were found to follow a desionoselective separation pattern. Despite its stability in alkaline media, ODMS does not seem to be as widely applicable a chiral resolving agent in high pH BGEs as it is in low pH BGEs, the first such behavior observed for a member of the 6-*O*-sulfo CD family.

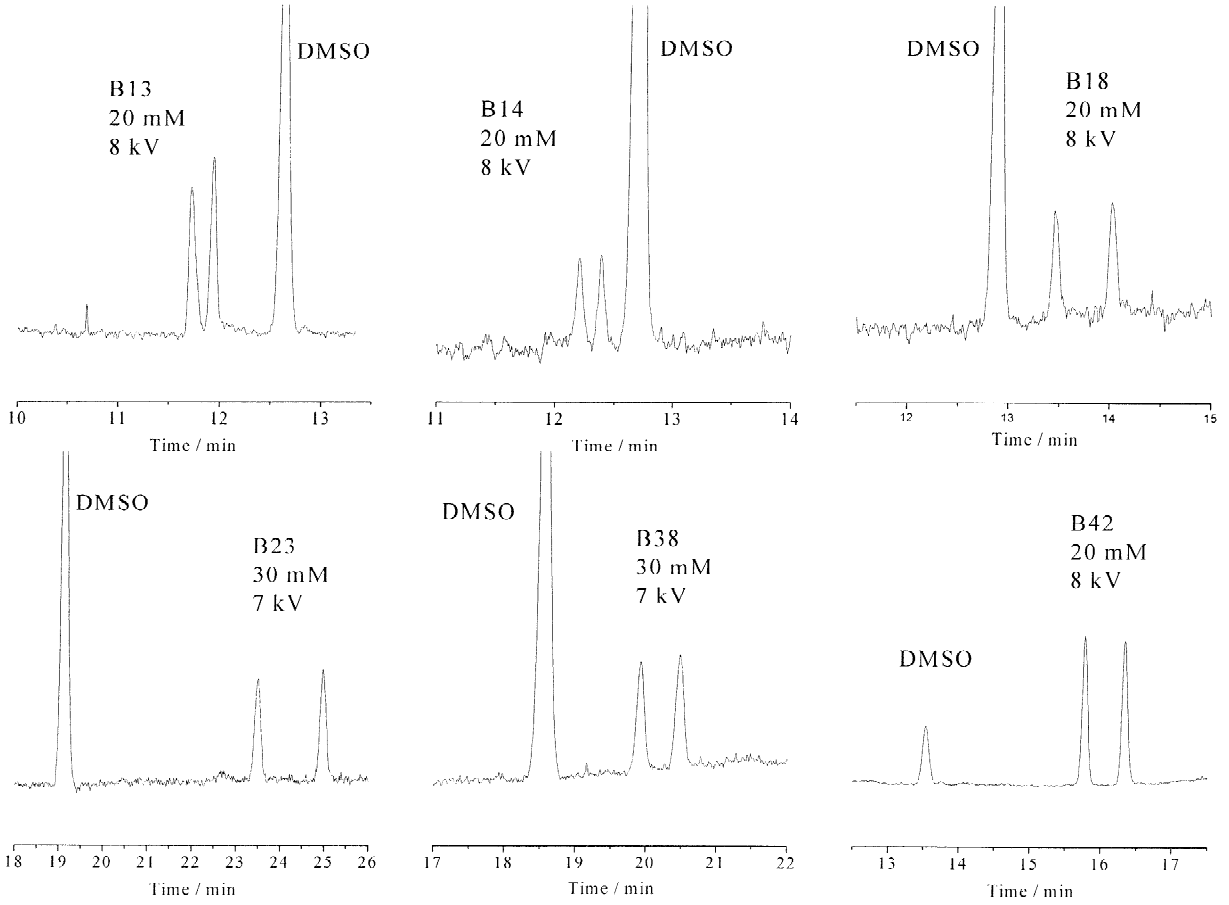


Fig. 3. Typical electropherograms of weak base analyte enantiomers. The numbers next to the compound codes (see Fig. 1) indicate the ODMS concentrations (m*M*) and applied potentials (kV) used. Capillary: 25 μm I.D., 39/46 cm effective/total length, uncoated, fused-silica. Other conditions see Experimental.

Acknowledgements

Partial financial support of this work by the Texas Coordination Board of Higher Education ARP-TDT program (Project Number 010366-016 and 010366-0152-1999), ANTEK Instruments, Inc. (Houston, TX, USA), Beckman-Coulter (Fullerton, CA, USA) and the Texas A&M University Gradipore Chair in Separation Science Endowment is gratefully acknowledged.

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