Separation of Enantiomers by Inclusion Gas Chromatography. On the Influence of Water in the Molecular Complexation of Methyl 2-Chloropropanoate Enantiomers and the Modified γ-Cyclodextrin Lipodex-E

ALESSANDRO MANDOLI[1] AND VOLKER SCHURIG[2]

[1]Dipartimento di Chimica e Chimica Industriale, Università di Pisa, Italy

[2]Institute of Organic Chemistry, University of Tübingen, Germany

Supporting Information

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1. Additional experiments with Column A

General conditions: 20 m×0.25 mm i.d fused silica column coated with 10% Lipodex-E in SE-54 (0.25 μm film thickness). A Perkin-Elmer Autosystem XL GC was used, with injector and detector temperature set to 250 °C. The separation was performed isothermally at the indicated temperature and 25.0 psi N_2.

1.1. Runs at 40°C

Conditions: Three analytical samples (***S1***-***S3***) were prepared as shown in Table 1. The measurements were carried out at 40 °C, in the split mode (split ratio = 1:30), by injecting 1 μL of the headspace vapors above the sample mixtures kept in sealed vials flushed with methane (C1) t_M marker. In the course of these runs, the conditioning trap was alternatively charged with Sicapent®, nothing, or $CuSO_4$•$5H_2O$. In some experiments, 1 μL of water was injected just after the C1 standard had reached the GC detector or just before the injection of the sample. Table 2 summarizes the actual working conditions and the scheme adopted for labeling the measurements of this set.

Table 1. Composition of samples ***S1***-***S3***.[a]

Sample	(*R*)-MCP [wt%]	(*S*)-MCP [wt%]	C9	C10	Water
S1	33.3	33.3	33.3	0	0
S2	25	25	25	25	0
S3	20	20	20	20	20

a: Methane was flushed inside the vial before sealing.

Table 2. Conditions and labeling of additional GC experiments with Column A at 40°C (for the other conditions, see the text).

Label	Conditioning trap		Sample			Water injection	
	Sicapent®	$CuSO_4 \cdot 5\ H_2O$	***S1***	***S2***	***S3***	after	before
Sicapent[a]	+		+	+			
None			+				
$CuSO_4$		+	+				
Sicapent (HS)	+				+		
Water after	+				+	+	
Water before	+				+		+

a: Initial runs carried out with ***S1***; ***S2*** used in the final ones.

The adjusted retention time *t'* of MCP enantiomers, C9 and, when present, C10 are reported in Figure 1, together with the trend in the enantioseparation factor $\alpha_{S,R}$.

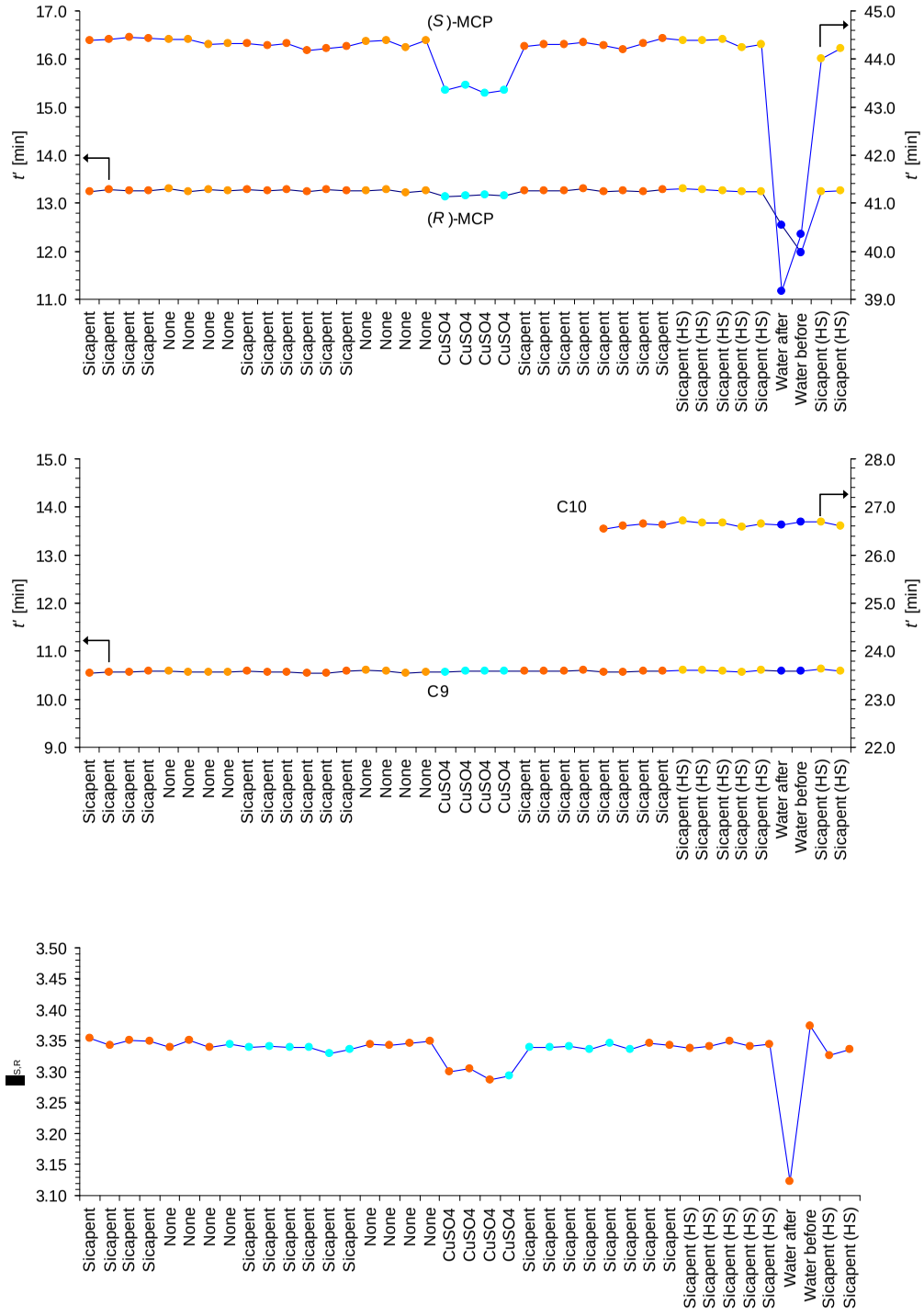

Figure 1. Adjusted retention time *t'* of MCP enantiomers, C9, and C10 and enantioseparation factor $\alpha_{S,R}$ on Column A at 40°C as a function of experimental conditions (for the meaning of abscissa labels, see Table 2). For the sake of clarity, data are color-coded according to conditions.

Table 3 summarizes retention data for this set of experiments.

Table 3. Total retention time t_M of C1 standard, adjusted retention time t' of C9, C10, and MCP enantiomers and corresponding standard deviations σ in the experiments of Figure 1.

Conditions[a]	C1		C9		(*R*)-MCP		C10		(S)-MCP	
	t_M [min]	σ_{tM} [min]	t' [min]	$\sigma_{t'}$ [min]	t' [min]	$\sigma_{t'}$ [min]	t' [min]	$\sigma_{t'}$ [min]	t' [min]	$\sigma_{t'}$ [min]
Sicapent	0.545	0.0029	10.570	0.0174	13.263	0.0195	26.608	0.0471	44.317	0.0813
None	0.545	0.0015	10.569	0.0197	13.263	0.0231	-[b]	-[b]	44.353	0.0591
$CuSO_4$	0.546	0.0006	10.576	0.0112	13.154	0.0141	-[b]	-[b]	43.359	0.0721
Sicapent (HS)	0.546	0.0016	10.593	0.0199	13.259	0.0232	26.651	0.0469	44.279	0.1421
Water after	0.544	-[c]	10.579	-[c]	12.540	-[c]	26.627	-[c]	39.167	-[c]
Water before	0.543	-[c]	10.585	-[c]	11.962	-[c]	26.685	-[c]	40.361	-[c]

a: for the meaning of labels, see Table 2. b: component not present in the analyzed sample. c: single measurement.

1.2. Runs at 50°C

Conditions: The measurements were carried out at 50 °C in split mode (split ratio = 1:50), by injecting 0.1 µL of 0.5 wt% *rac*-MCP in cyclohexane. Because no hydrocarbon standard was used in these experiments, only the total retention time (t) and the unadjusted relative retention ($\alpha_G = t_{S\text{-}MCP}/t_{R\text{-}MCP}$) of MCP enantiomers are provided.

In the course of these runs, the conditioning trap was alternatively charged with water, nothing, MS-13X, or $CuSO_4 \bullet 5H_2O$.

Figure 2 summarise retention parameters for this set of experiments.

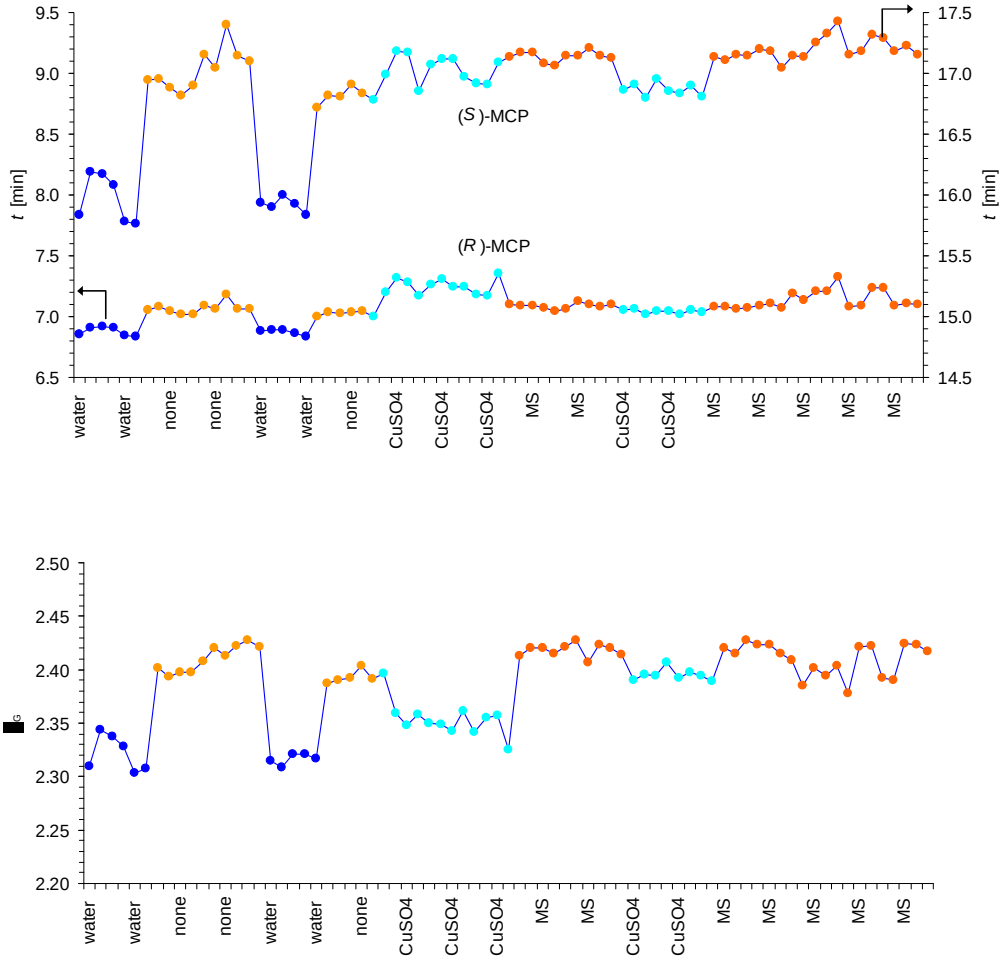

Figure 2. Total retention time t (*top*) and unadjusted relative retention α_G of MCP enantiomers (*bottom*), on Column A at 50°C, as a function of the content of the conditioning trap placed inline to carrier supply. For the sake of clarity, data are color-coded according to conditions.

2. Experiments with column B

General conditions: 25 m×0.25 mm i.d fused silica column coated with 5% Lipodex-E in SE-30 (0.25 μm film thickness). A Perkin-Elmer Autosystem XL GC was used, with injector and detector temperature set to 250 °C. The separation was performed isothermally at the indicated temperature and 20.0 psi N_2.

2.1. Runs at 40°C

Conditions: The measurements were carried out in splitless mode at 40 °C, by injecting 0.2 μL of the headspace vapours above sample ***S2*** contained in a sealed vial.

In the course of these runs, the conditioning trap was alternatively charged with MS-13X or $CuSO_4 \bullet 5H_2O$. Figure 3 summarises retention data for this set of measurements.

2.2. Runs at 50°C

Conditions: The measurements were carried out at 50 °C in split mode (split ratio = 1:50), by injecting 0.1 μL of 0.5 wt% *rac*-MCP in cyclohexane. Because no hydrocarbon standard was used in these experiments, only the total retention time (t) and the unadjusted relative retention ($\alpha_G = t_{S\text{-}MCP}/t_{R\text{-}MCP}$) of MCP enantiomers are provided.

In the course of these runs, the conditioning trap was alternatively charged with water, nothing, MS-13X, or $CuSO_4 \bullet 5H_2O$. Figure 4 summarise retention data for this set of measurements.

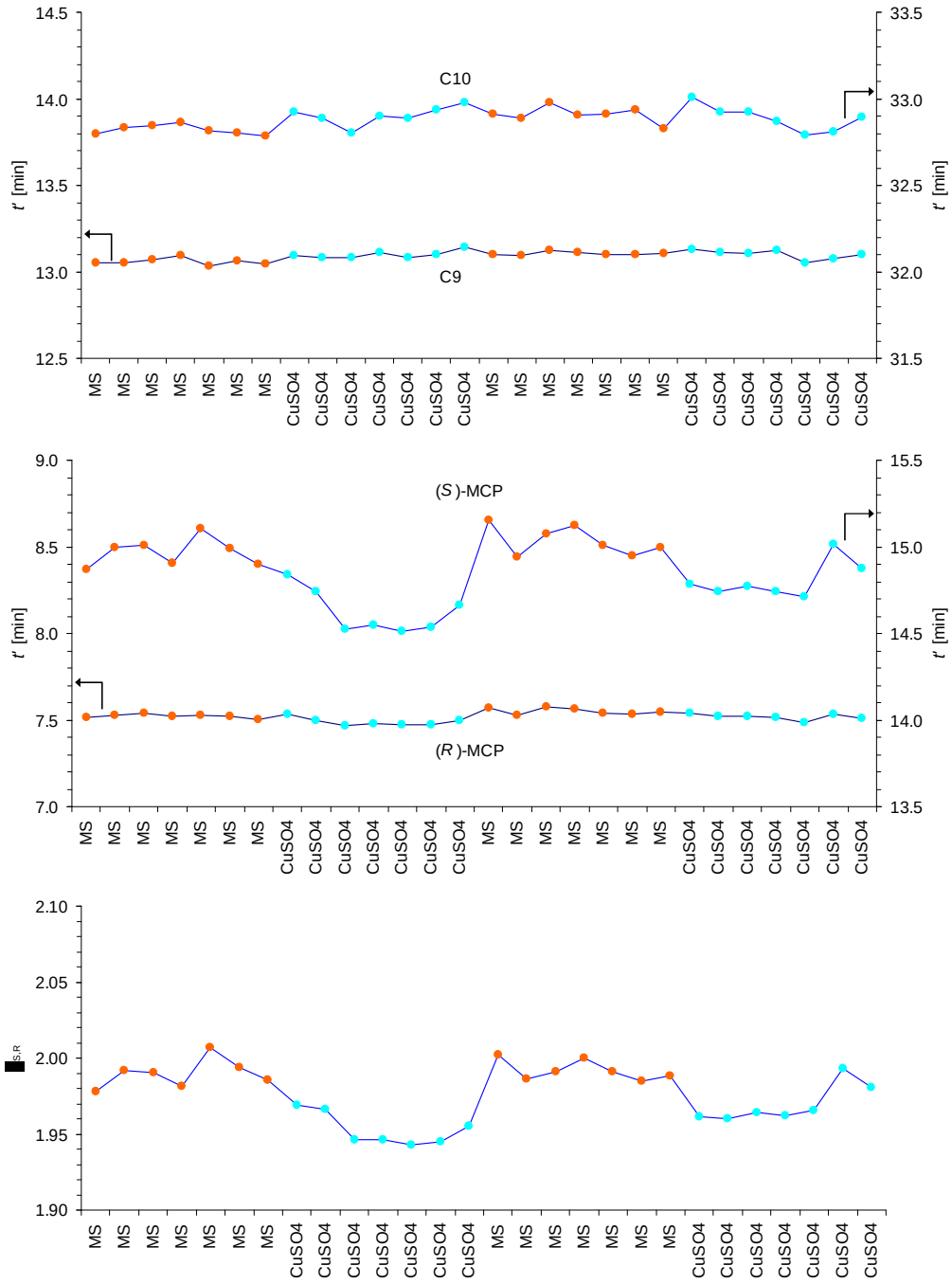

Figure 3. Adjusted retention time *t'* of C9 and C10 hydrocarbon standards (*top*) and MCP enantiomers (*middle*) and enantioseparation factor $\alpha_{S,R}$ (*bottom*), on Column B at 40°C, as a function of the content of the conditioning trap placed inline to carrier supply. For the sake of clarity, data are color-coded according to conditions.

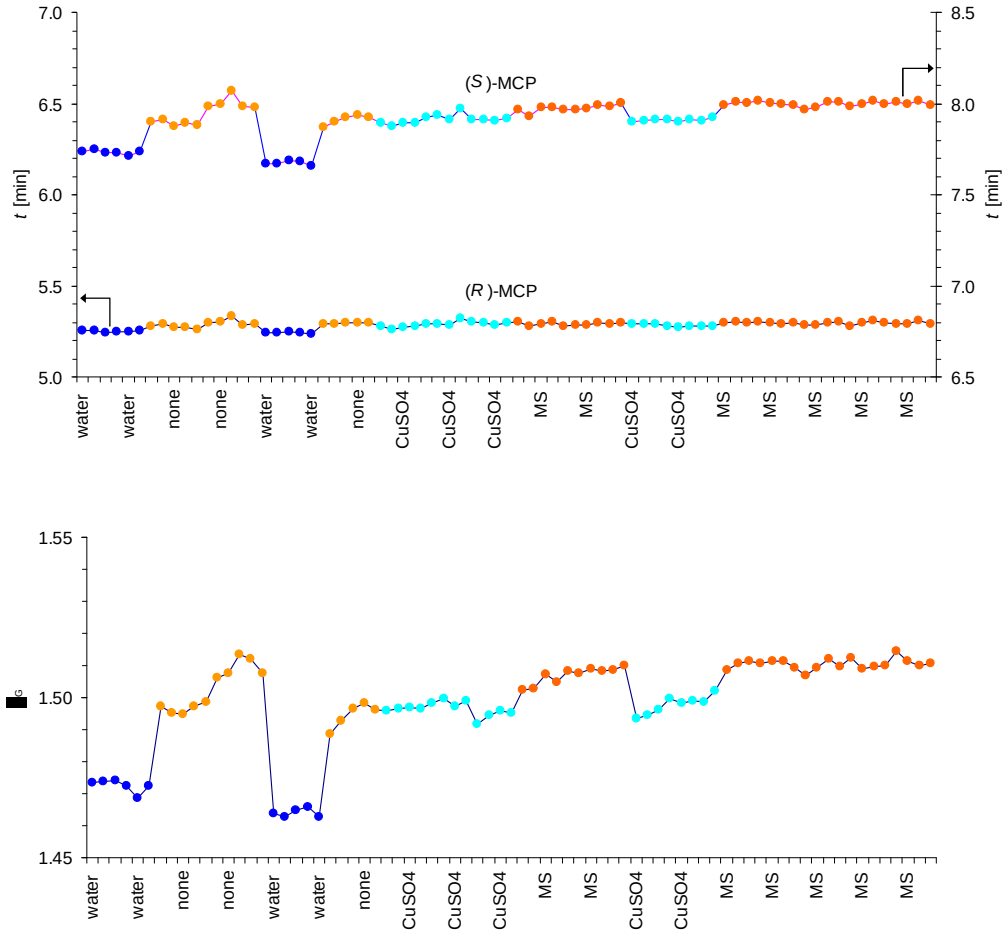

Figure 4. Total retention time *t* (*top*) and unadjusted relative retention α_G of MCP enantiomers (*bottom*), on Column B at 50°C, as a function of the content of the conditioning trap placed inline to carrier supply. For the sake of clarity, data are color-coded according to conditions.

3. Experiments with column C

Conditions: 20 m×0.25 mm i.d fused silica column coated with 100% Lipodex-E (0.25 μm film thickness). Measurements carried out at 60 °C isothermal and 40 kPa H_2, with a Thermo Finnigan Trace GC. Injector and detector temperature was set to 250 °C and a split ratio of 1:50 was used. *n*-Undecane (C11) was employed as the reference hydrocarbon standard.

In selected experiments, the humidity content was affected by simultaneous injection of a certain volume of water with the sample solution. Typical chromatograms are shown in Figure 5, while Table 4 and Figure 6 summarise retention data for the whole set of measurements.

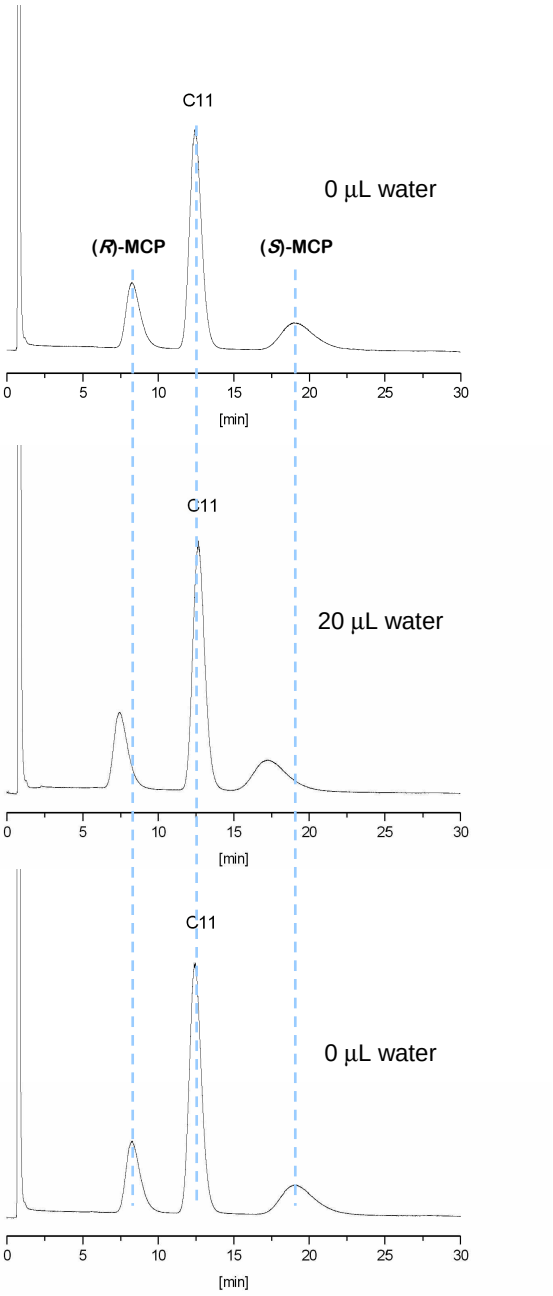

Figure 5. Separation of MCP enantiomers and C11 at 60°C, on neat Lipodex-E phase: without co-injection of water (*top* and *bottom*) and with simultaneous injection of 20 µl water (*middle*).

Table 4. Effect of co-injected water on retention factors *k* of MCP enantiomers and C11, on neat Lipodex-E phase at 60°C.

V_{H2O} [µl]	k_R	k_S	k_{C11}	α
0	8.98	22.03	14.07	2.45
0	8.98	22.11	14.02	2.46
10	8.68	21.16	14.20	2.44
20	8.02	19.91	14.32	2.48
30	7.87	19.61	14.37	2.49
30	8.42	20.90	14.21	2.48
30	8.42	20.69	14.22	2.46
0	9.03	22.03	14.07	2.44
0	9.03	21.95	14.07	2.43
0	9.03	22.18	14.07	2.46
0	9.03	22.01	14.07	2.44
0	9.03	22.03	14.07	2.44
30	8.37	20.50	14.42	2.45

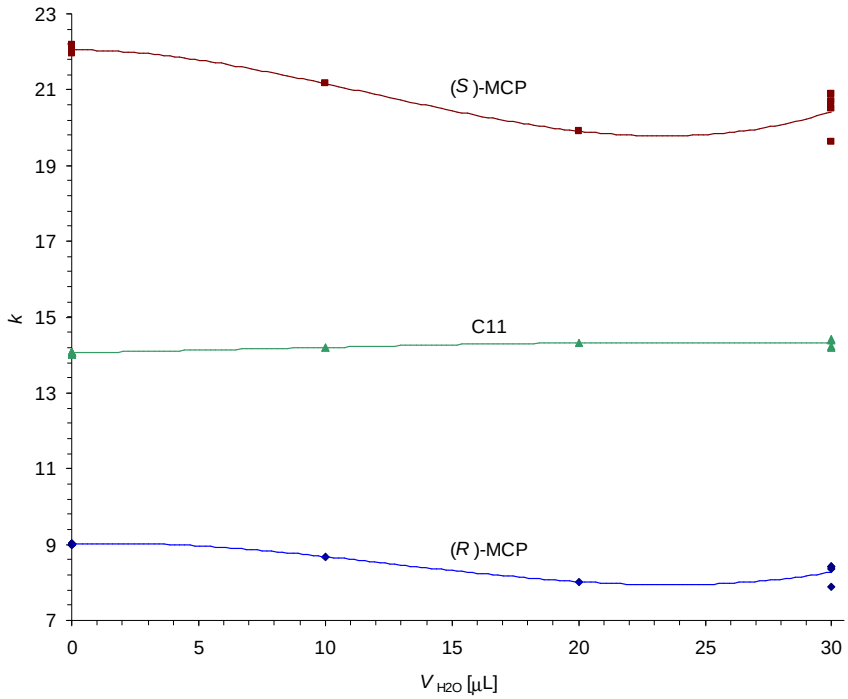

Figure 6. Changes of retention factors of MCP enantiomers and C11, on neat Lipodex-E phase at 60°C, as a function of the volume of co-injected water.