Electronic Supplementary Material (ESI) for RSC Advances.


# Poly(vinyl alcohol)-cationic cellulose copolymer encapsulated $SiO_2$ stationary phase for hydrophilic interaction liquid chromatography

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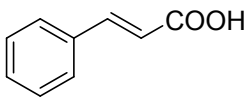
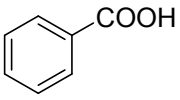
**Experimental**

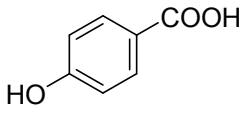
Elemental analysis was studied on a Varil EL III Element Analyzer (ELEMENTAR Analysen system GmbH, Germany). X-ray photoelectron spectroscopy (XPS) was obtained with an Escalab 250Xi photoelectron spectrometer (Thermo Scientific, NY, USA). Zeta-potential analysis was performed on a Malvern Zerasizer Nano ZS90 (Malvern, UK).



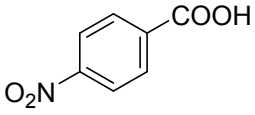

Cinnamic acid



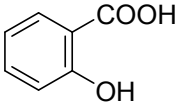

Benzoic acid



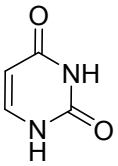

4-Hydroxybenzoic acid



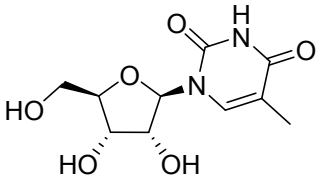

4-Nitrobenzoic acid




Salicylic acid




Uracil

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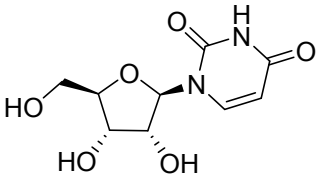


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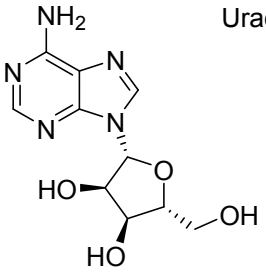


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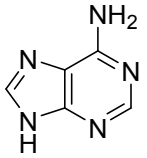


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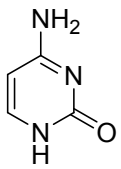
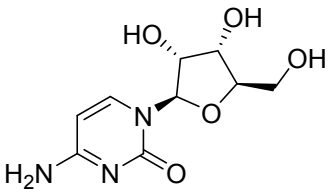
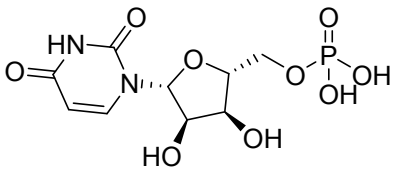



Cytosine




Cytidine



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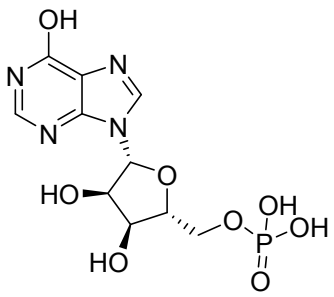

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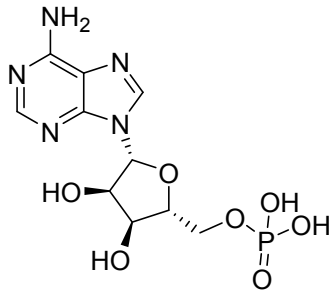

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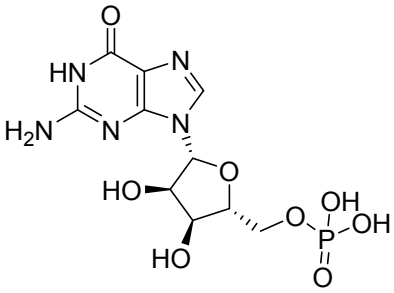

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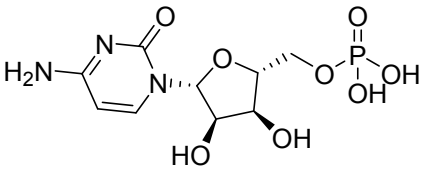
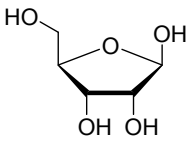


cytidylic acid, CMP



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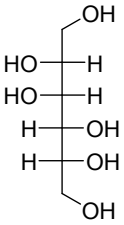

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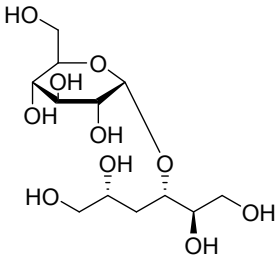

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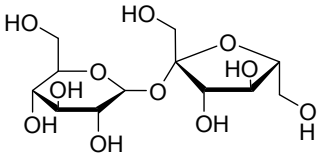

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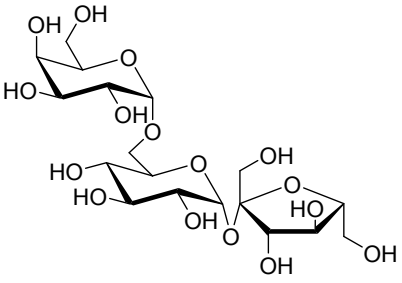

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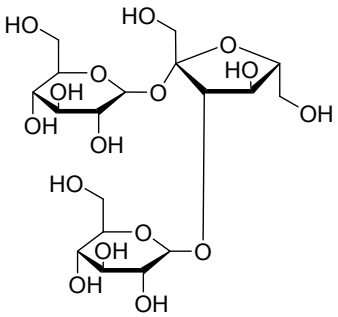

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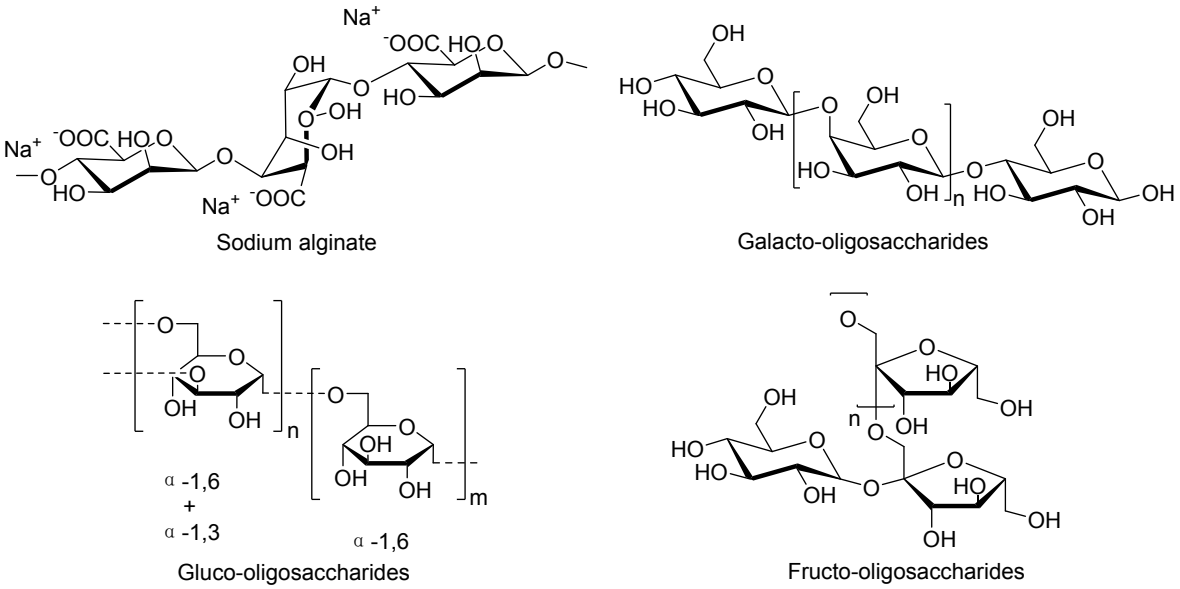
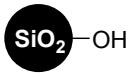
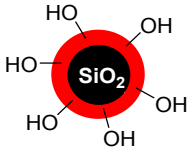
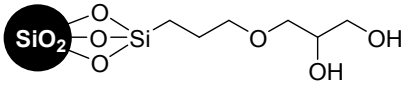
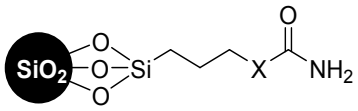
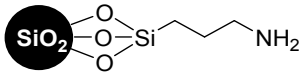
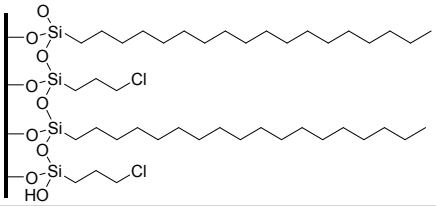



**SI-Scheme 1** Chemical structures of the analytes chosen for chromatographic evaluation

### *1.1 Zeta-potential measurement*

Into 1 mL of 1.67 mg/mL bare silica or PVA-CC-Sil dispersion in water was added 2 mL of 100 mM $HCOONH_4$ at different pH values. The mixture was then diluted with deionized water to a final volume of 10 mL and subjected to sonication for 1 min before test.

**SI-Table 1** Chemical information of the domestic columns used for comparison

| Column name | Bonded phase | Chemical Structure |
|---|---|---|
| Bare silica | none |  |
| PVA-Sil | diol |  |
| ACCHROM Unitary Diol | diol |  |
| ACCHROM XAmide | amide |  |
| ACCHROM Unitary $NH_2$ | amine |  |
| ACCHROM SAX | amine | |
| ACCHROM Click XIon | ZIC | |
| ACCHROM XAqua C18 | C18 |  |
| ACCHROM Xcharge C18 | C18 | |

**SI-Table 2** Elemental analysis of PVA-Sil and PVA-CC-Sils

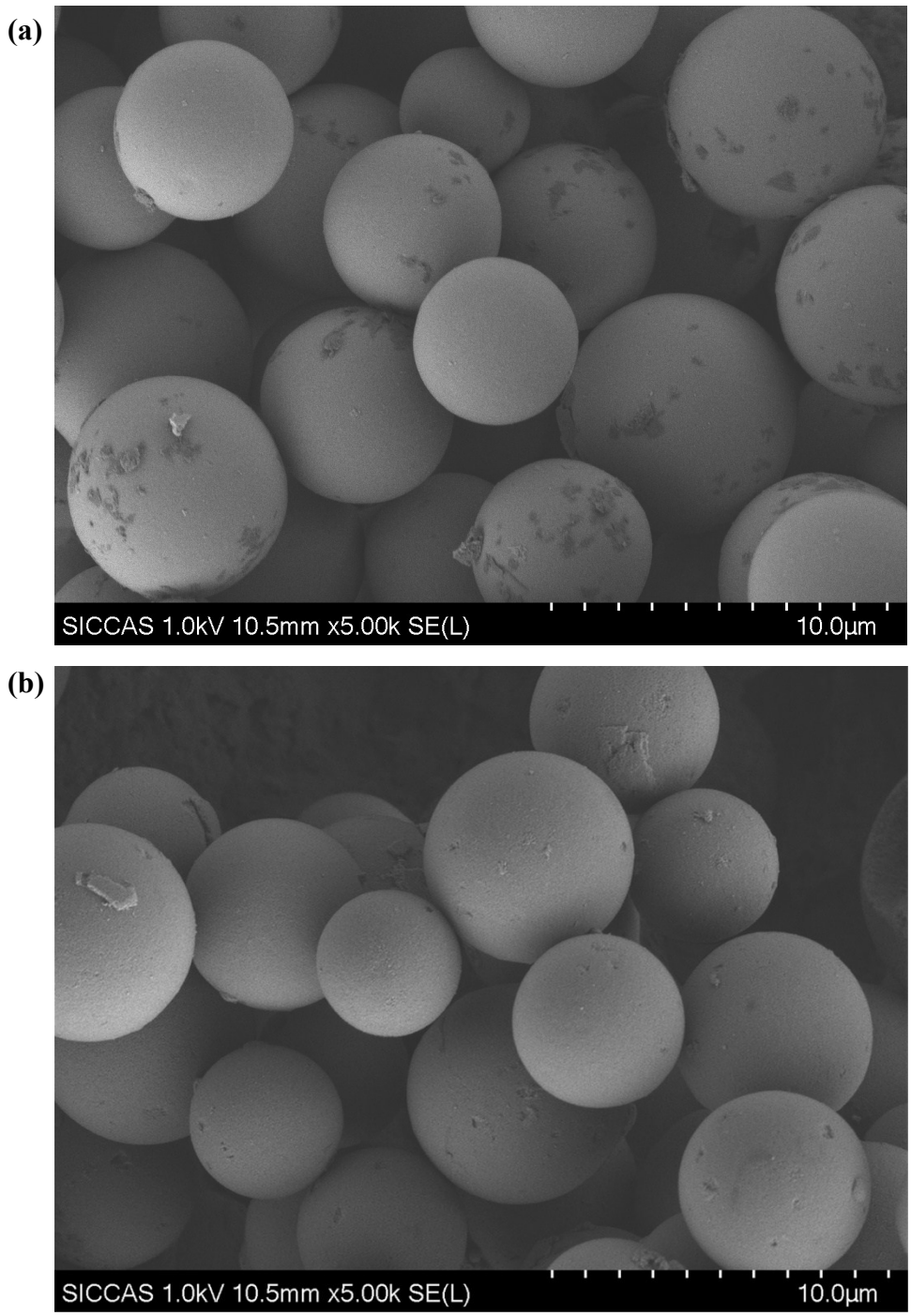
| Stationary phases | C% | N% | H% | Loading of cationic cellulose (mg/g) |
|---|---|---|---|---|
| Bare silica gel | 0.55 | - | 1.26 | - |
| PVA | 54.55 | - | 9.09 | - |
| Cationic cellulose | 37.87 | 2.06 | 6.43 | - |
| PVA-CC-Sil | 8.85 | 0.11 | 2.17 | 53.88 |

**SI-Table 3** Surface and pore analysis of bare silica gel and PVA-CC-Sil

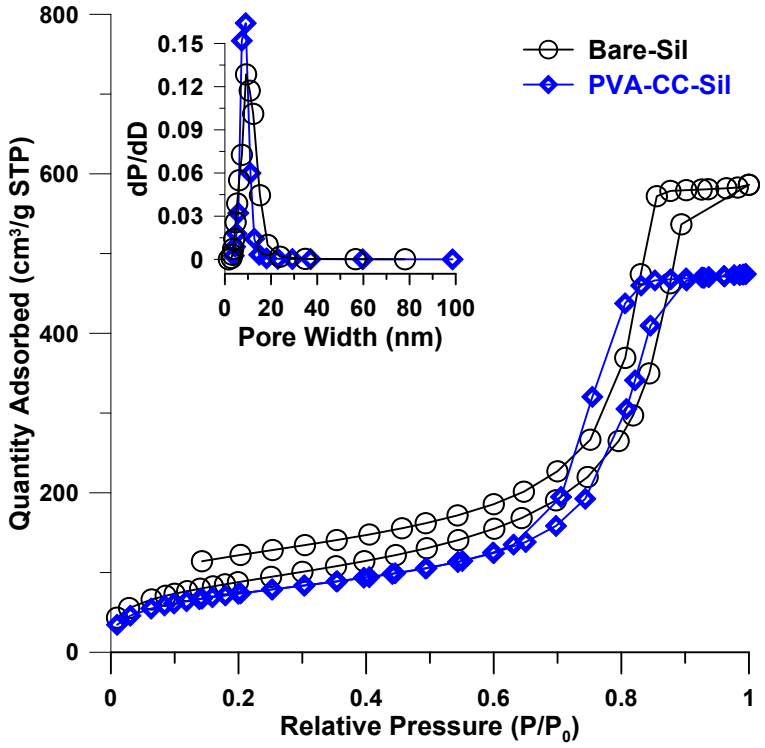
| Stationary phases | BET Surface area ($m^2/g$) | BJH Adsorption Pore Volumn ($cm^3/g$) | BJH Adsorption Pore Diameter (Å) |
|---|---|---|---|
| Bare silica gel | 324 | 0.92 | 97 |
| PVA-CC-Sil | 271 | 0.74 | 92 |

**SI-Table 4** van't Hoff equations of five nucleosides and nucleic acid bases on PVA-CC-Sil

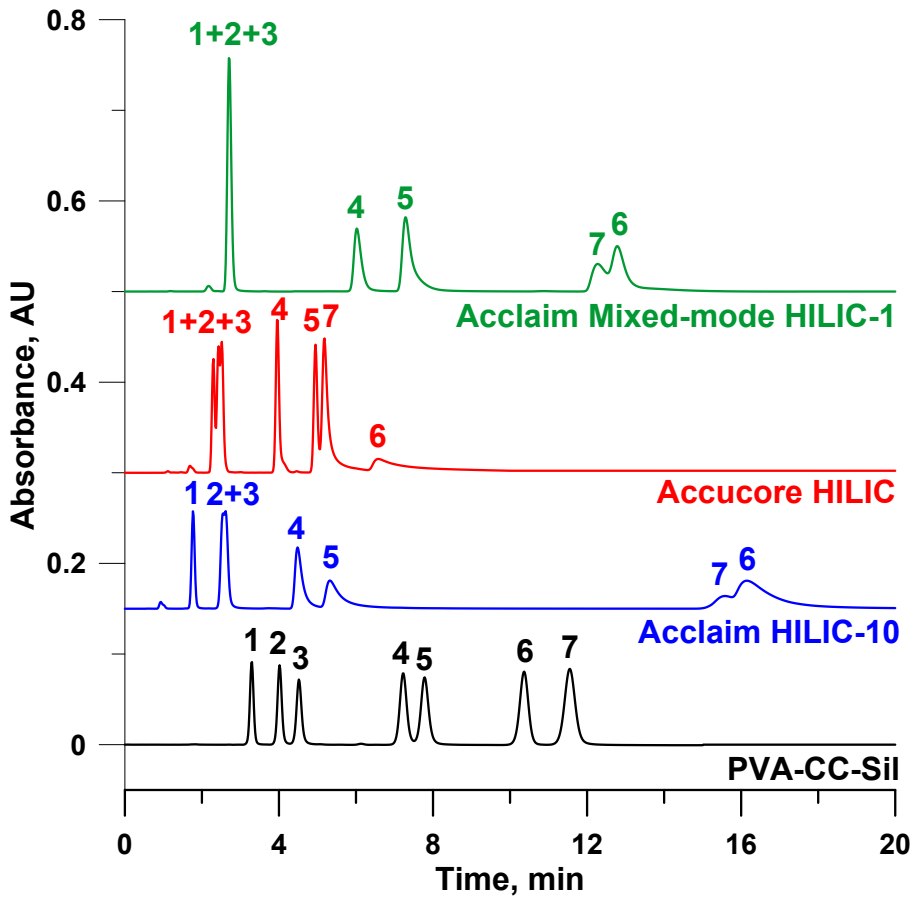
| Analyte | $-\frac{\Delta H^0}{R}$ | $\frac{\Delta S^0}{R} + \ln \Phi$ | Retention enthalpy (kJ/mol) | $r^2$ |
|---|---|---|---|---|
| Uracil | 495.274 | -1.299 | -4.1 | 0.990 |
| 5-Methyluridine | 767.292 | -1.908 | -6.4 | 0.999 |
| Uridine | 768.474 | -1.743 | -6.4 | 0.998 |
| Adenine | 848.544 | -1.271 | -7.1 | 0.997 |
| Cytosine | 691.723 | -0.426 | -5.8 | 0.999 |




**SI-Fig. 1** Scanning electron micrographs of (a) bare silica gel and (b) PVA-CC-Sil

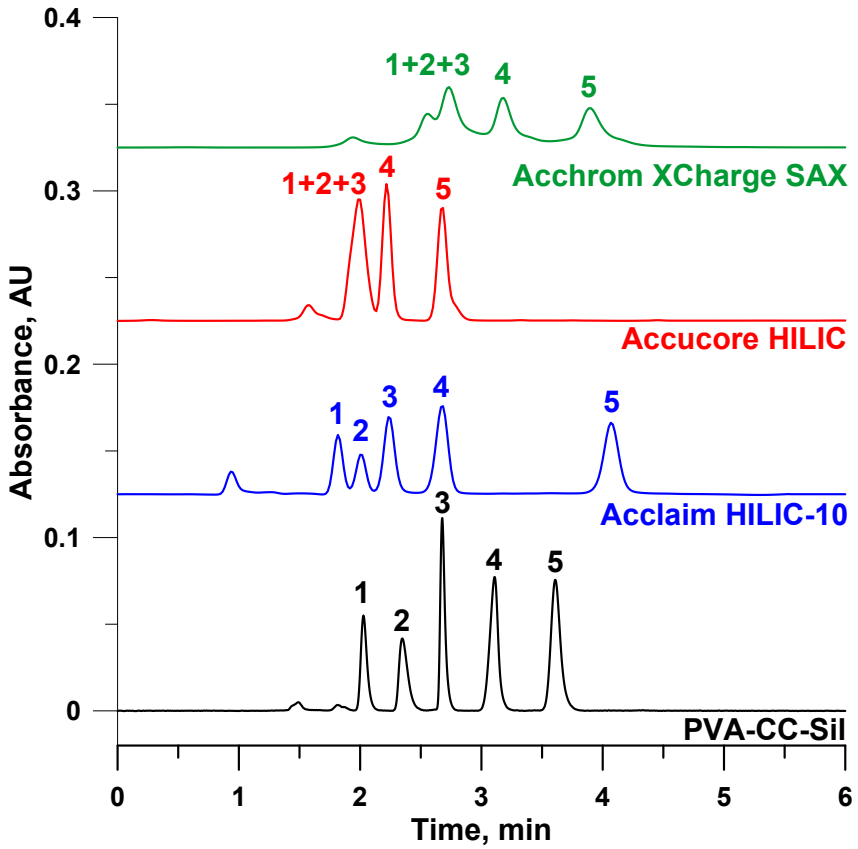



**SI-Fig. 2** $N_2$ adsorption-desorption isotherms and BJH-adsorption pore size distribution of bare silica gel and PVA-CC-Sil.



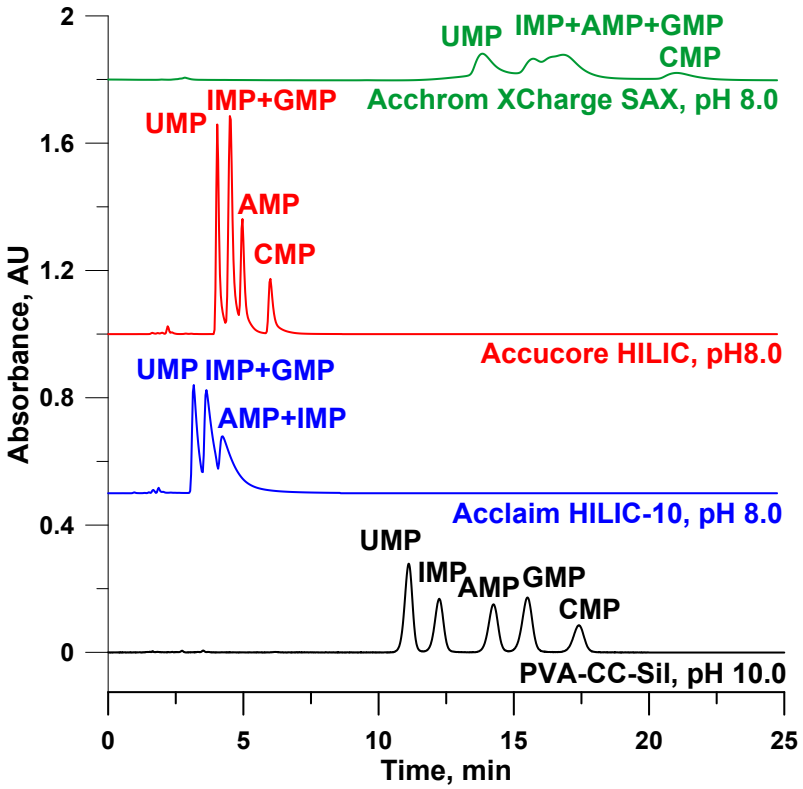

**SI-Fig. 3** Comparative separation chromatograms of nucleosides on PVA-CC-Sil, Acclaim HILIC-10, Accucore HILIC and Acclaim Mixed-mode HILIC-1.

Conditions: 90% ACN/10% $H_2O$ for PVA-CC-Sil and Accucore HILIC; 95% ACN/5% $H_2O$ for Acclaim HLIC-10 and Acclaim Mixed-mode HILIC-1; other conditions same as Fig. 3b.



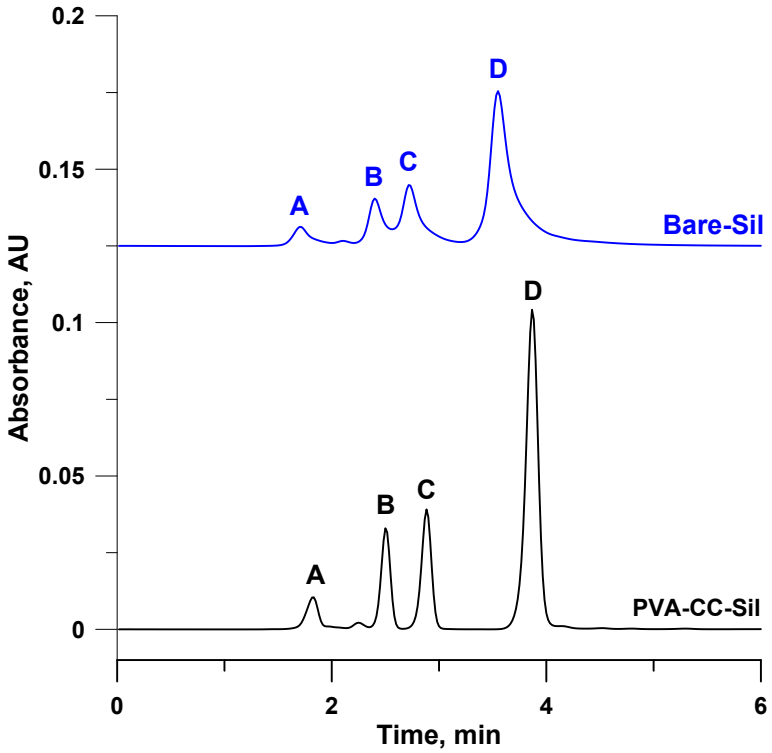

**SI-Fig. 4** Comparative separation chromatograms of aromatic acids on PVA-CC-Sil, Acclaim HILIC-10, Accucore HILIC and Acchrom XCharge SAX.

Conditions: 90% ACN/10% $H_2O$ (250 mM $HCOONH_4$, pH 3.48) for PVA-CC-Sil, Accucore-HILIC and Acchrom XCharge SAX; 95% ACN/5% $H_2O$ (250 mM $HCOONH_4$, pH 3.48) for Acclaim HLIC-10; other conditions same as Fig. 3a.



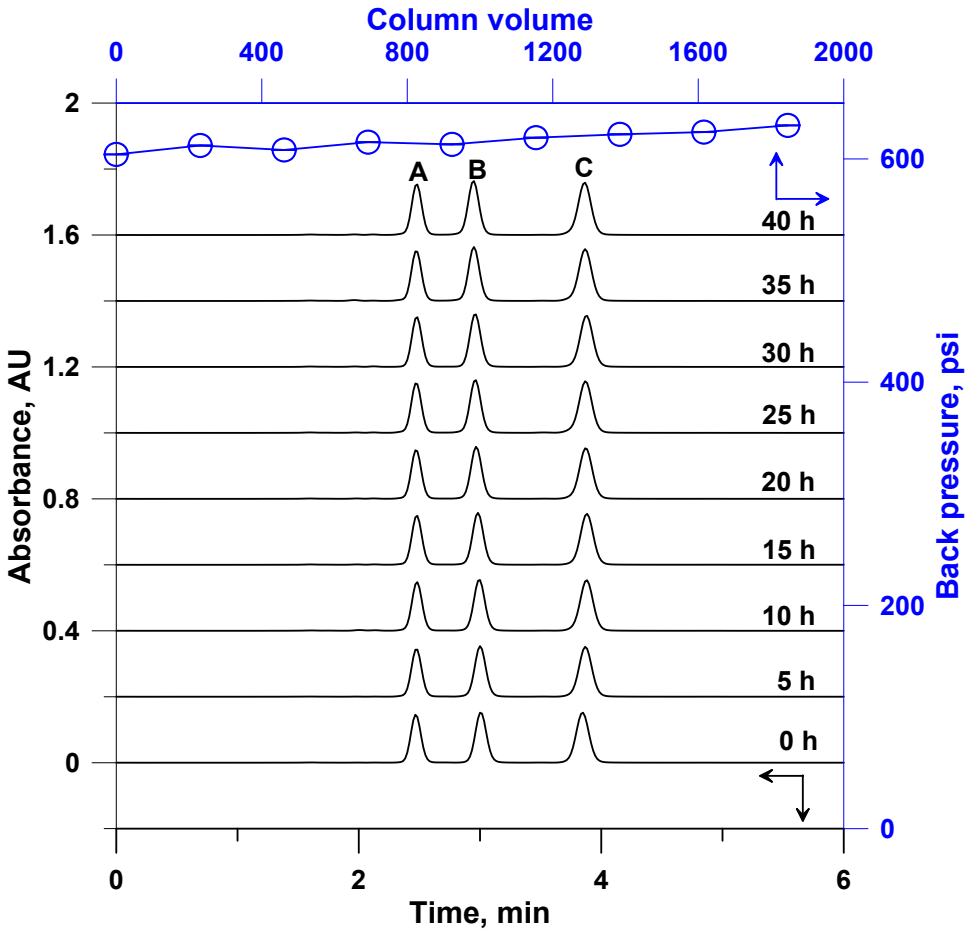

**SI-Fig. 5** Comparative separation chromatograms of nucleotides on PVA-CC-Sil, Acclaim HILIC-10, Accucore HILIC and Accrom XCharge SAX.

Condition same as Fig. 4.



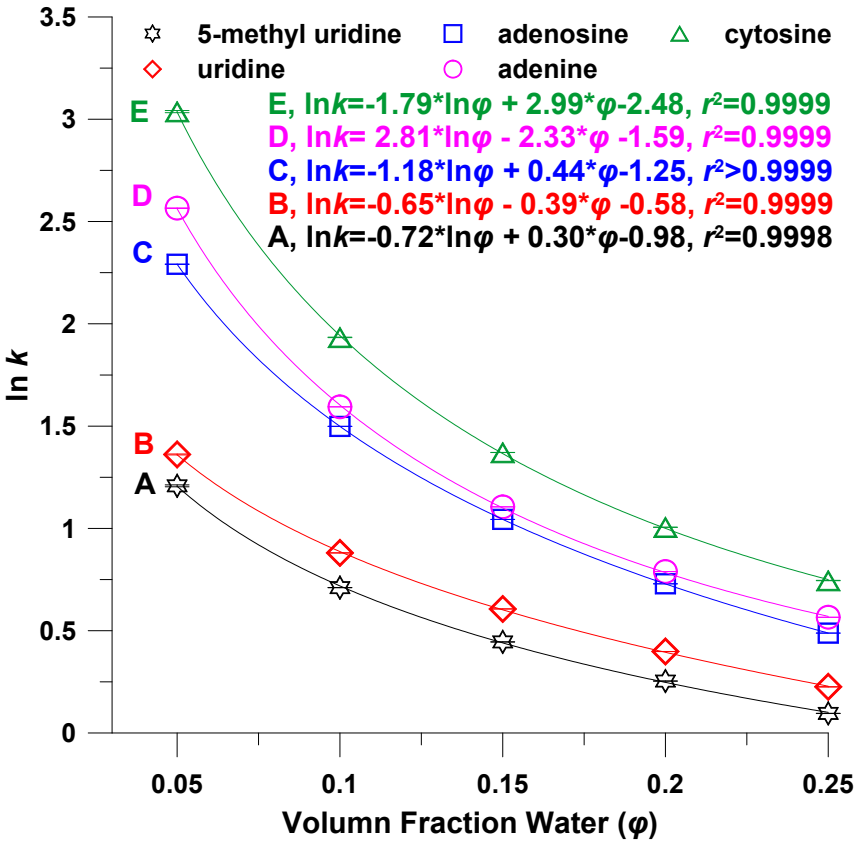

**SI-Fig. 6** Comparative separation chromatograms of small molecular bases on PVA-CC-Sil and bare-sil.

Conditions: 90% ACN/10% $H_2O$ (250 mM $HCOONH_4$, pH 5.87); analytes, A, 4-methyl aniline; B, caffeine; C, theobromine; D, diprophyline; injection volume, 5 µL; other conditions same as Fig. 3.



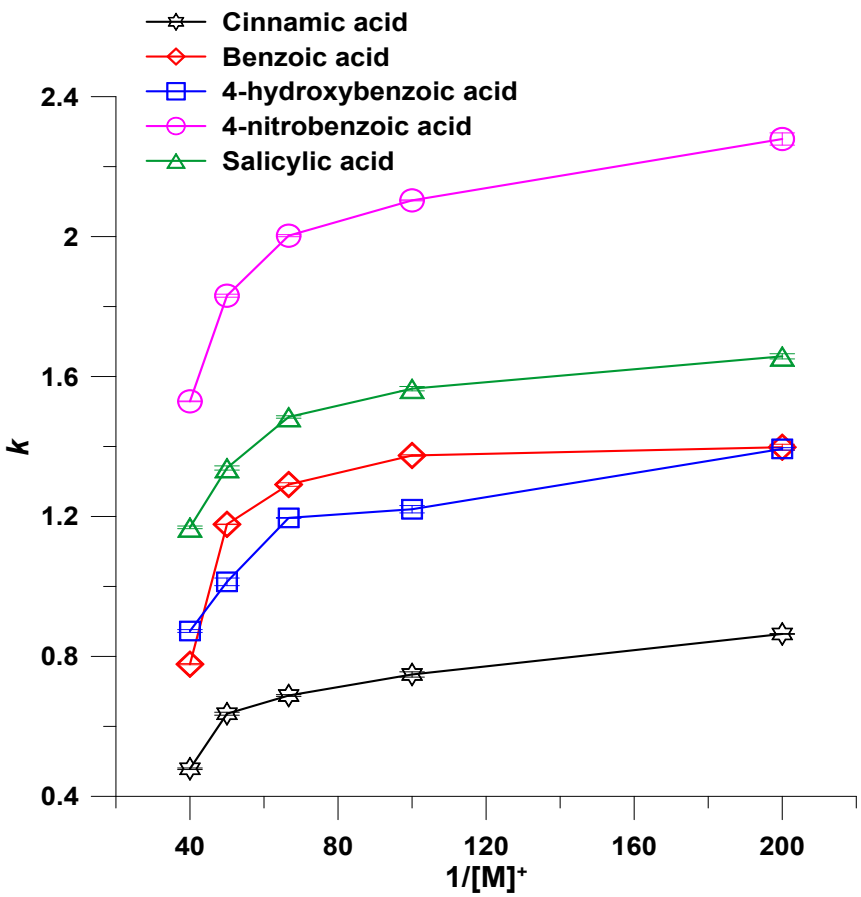

**SI-Fig. 7** Chemical stability of PVA-CC-Sil stationary phase.

Conditions: mobile phase, 75% ACN/25% $H_2O$ (20 mM $NH_4OAc$, pH 6.87); analytes, A, diprophyline; B, 4-aminobenzoic acid; C, cytidine; injection volume, 5 µL; other conditions same as Fig. 3.



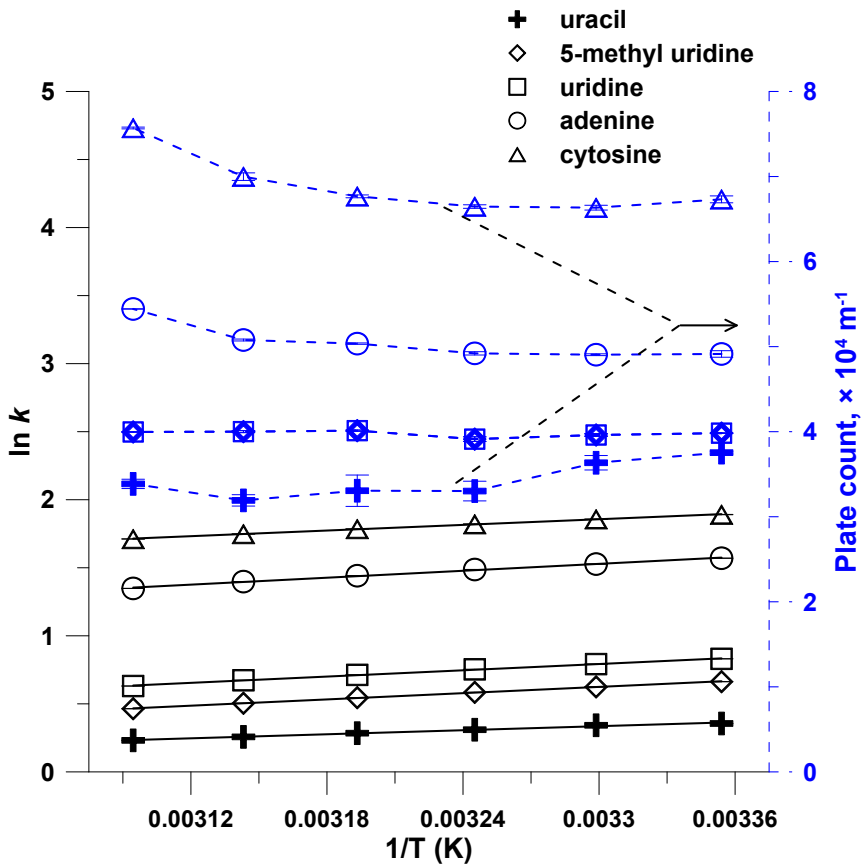

**SI-Fig. 8** Plots of ln *k* vs. volume fraction water in mobile phase for nucleosides onto PVA-CC-Sil.

Conditions: mobile phase of ACN/$H_2O$ varied as indicated; other conditions same as Fig. 3.



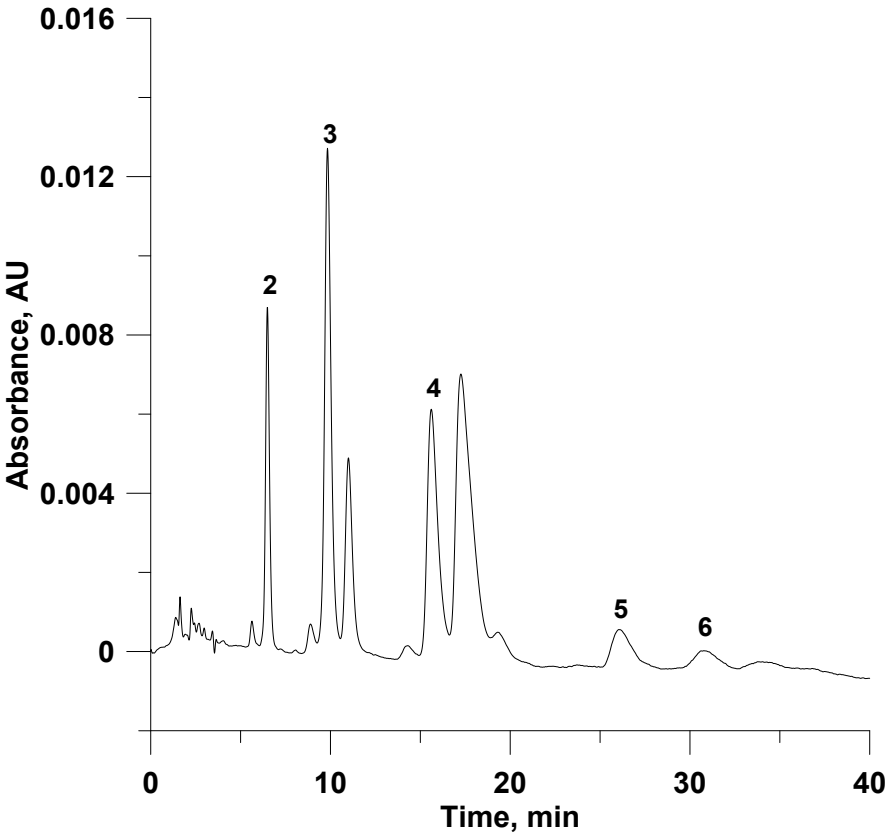

**SI-Fig. 9** Plots of retention factors vs. the reciprocal of eluent electrolyte concentration on the retention for five aromatic acids onto PVA-CC-Sil.

Conditions: mobile phase, $HCOONH_4$, concentration as noted, pH 3.48 with 90% ACN; other conditions same as Fig. 3.



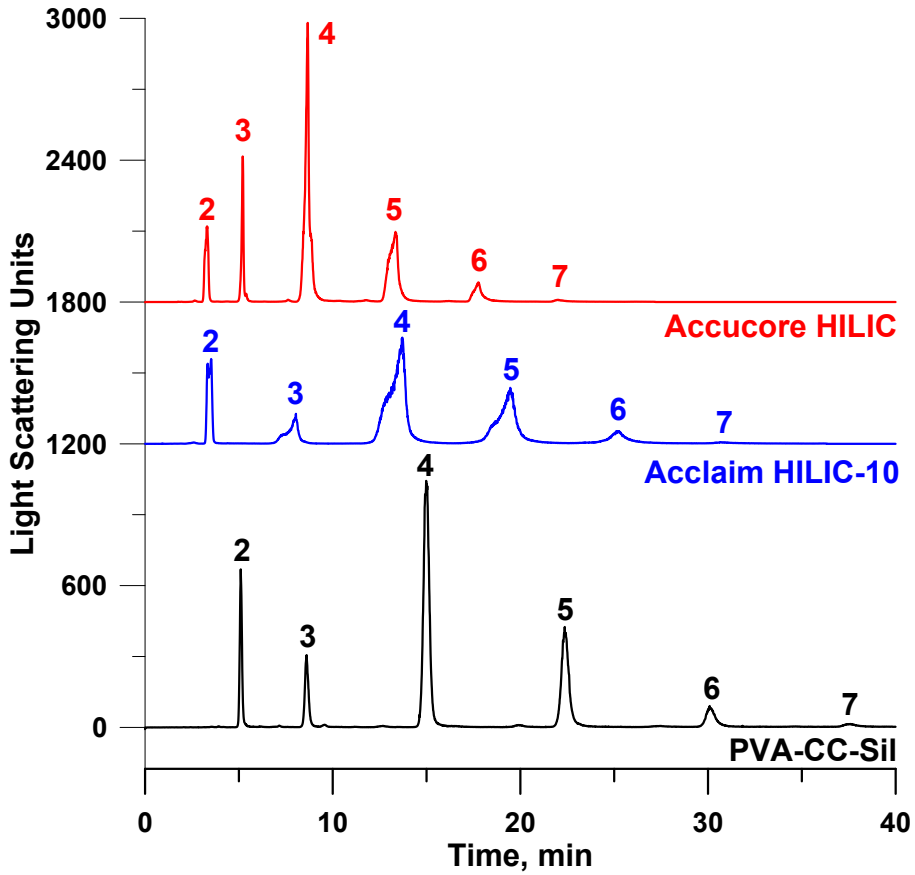

**SI-Fig. 10** Retention factor dependency on column temperature for five nucleosides and nucleic acid bases onto PVA-CC-Sil.

Conditions: mobile phase, 90% ACN/ 10% $H_2O$; temperature as indicated; other conditions same as Fig. 3.




**SI-Fig. 11** Chromatogram of sodium alginate onto PVA-CC-Sil.

Condition: mobile phase, A, $H_2O$; B, ACN; C, 250 mM $HCOONH_4$, A/B/C (v/v/v), 15/65/20; injection volume, 5 µL; other conditions same as Fig. 3.




**SI-Fig. 12** Comparative separation chromatograms of galacto-oligosaccharides on PVA-CC-Sil, Acclaim HILIC-10 and Accucore HILIC.

Conditions: mobile phase, A, 100 mM $HCOONH_4$; B, ACN; C, MeOH, 0-60 min, A/B/C (v/v/v), 10/70/20→10/30/60 for PVA-CC-Sil, 10/90/0→10/50/40 for Acclaim HILIC-10 and 10/80/10→10/40/50 for Accucore HILIC; other conditions same as Fig. 6.