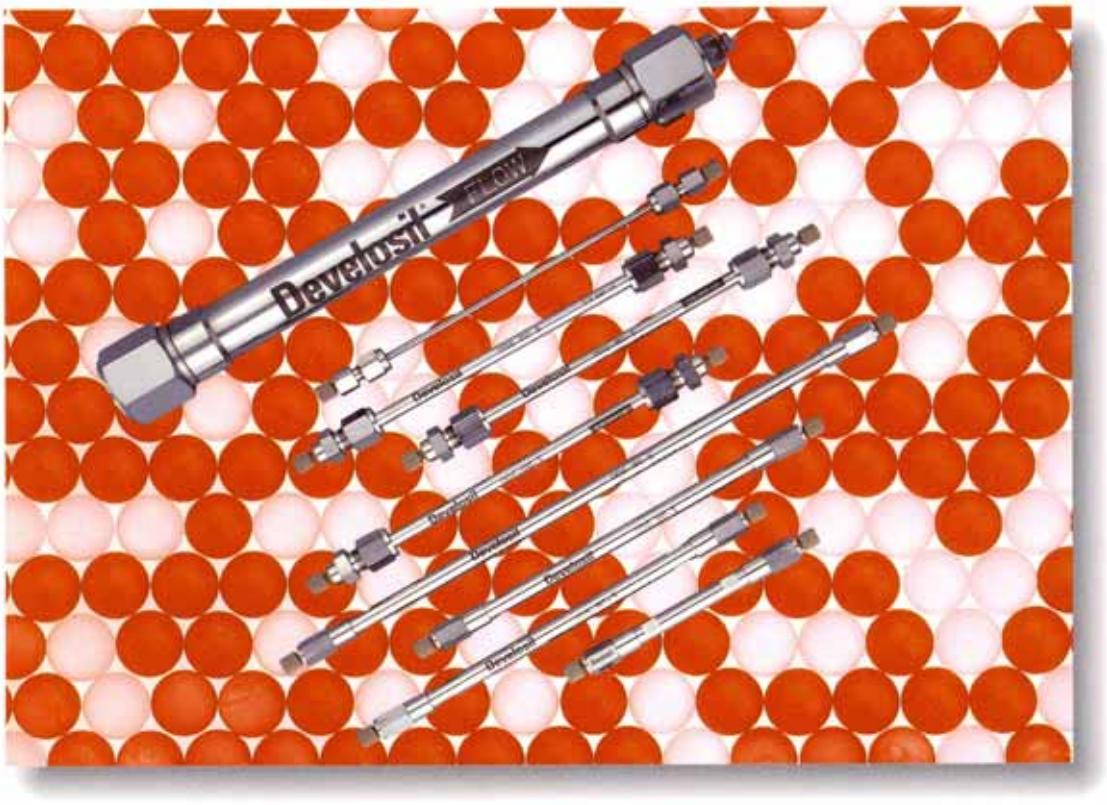
Columns for HPLC

Develosil™



Nomura Chemical Co., Ltd.

Nomura Chemical

Nomura Chemical Co. started and has continued till present as a maker of Develosil HPLC column since 1979. We manufacture from silica gel to a final column, and also provide Develosil silica gel or Develosil ODS phases to the other HPLC makers. We are one of leading companies for HPLC column in the world. Especially our patented C30 phase has a unique characteristics and has been used by many pharmaceuticals.
Develosil columns are available in the world through our distributors in North America, Europe and etc.

Develosil HPLC column

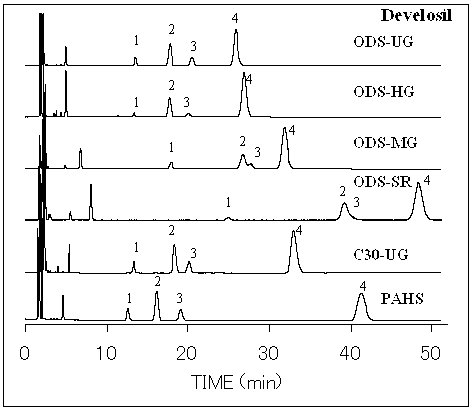
Columns in 3 kinds of mode such as Reversed, Gel filtration and Normal phase are commercially available. We have 5 kinds of C30 phase, 6 kinds of C18 (ODS) phase and 2 kinds of C8 phase. 300ODS-HG, 300C8-HG and 300C4-HG phases have pores with 25 nm diameter and are for separation of proteins. We have 4 kinds of silica gel. Especially Develosil 30 (silica gel) has 3nm pores. Its pore size is the smallest, and it has very large surface area and shows large retention.

Reversed phase	C30 phase	Develosil C30-UG	3 um, 5 um
		Develosil PRPAQUEOUS	3 um, 5 um
		Develosil Combi-RP	3 um, 5 um
		Develosil RPFULLERENE	3 um, 5 um
		Develosil RPAQUEOUS-AR	3 um, 5 um
		Develosil ERP20	15/30 um
	C18 phase	Develosil ODS-UG	3 um, 5 um and 15/30 um
		Develoisl ODS-HG	3 um, 5 um and 15/30 um
		Develosil ODS-MG	3 um, 5 um and 15/30 um
		Develosil ODS-SR	3 um, 5 um and 15/30 um
		Develosil PAHS	3 um, 5 um
		Develosil 300ODS-HG	5 um
	C8 phase	Develosil C8-UG	3 um, 5 um
		Develoisl 300C8-HG	5 um
	C4 phase	Develoisl 300C4-HG	5 um
	C1 phase	Develosil TMS-UG	3 um, 5 um
	Phenyl phase	Develosil Ph-UG	3 um, 5 um
	Cyano phase	Develosil CN-UG	5 um
Gel filteration phase	Diol phase	Develosil 300Diol	5 um
		Develosil 100Diol	5 um
Normal phase	Cyano phase	Develosil CN-UG	5 um
	Amino phase	Develoisl NH2	5 um
	Silica	Develosil 30	3 um, 5 um and 15/30 um
		Develosil 60	3 um, 5 um and 15/30 um
		Develosil 100	3 um, 5 um and 15/30 um
		Develosil SILICA-HILIC(I)	3 um, 5 um

C18 phase

Develosil	ODS-UG	ODS-HG	ODS-MG	ODS-SR	PAHS
Functionatrity of C18	Monofunctional	Trifunctional	Difunctional	Difunctional	Trifunctional and polymeric
Ligand density (umol/g)	3.2	3.4	1.6	---	4.5
Carboncontent (%)	18	18	15	18	23
Endcapping (TMS)	Yes	Yes	Yes	Yes	No
Pore diameter of silica (nm)	14	14	10	8	12
Surface area of silica (m2/g)	300	300	450	---	350
Hydrogen bonding capacity k(caffeine)/k'(phenol)	0.38	0.38	0.48	0.48	0.40
Hydrophobic consistency k'amylbenzene)/k'(butyl benzene)	1.59	1.58	1.60	1.66	1.58
Steric selectivity k(triphenylene)/k'(o-terphenyl)	1.50	1.58	1.20	1.21	2.72
Stability	Very good (pH1-10)	Very good (pH1-9)	Good (pH2-7.5)	Good (pH2-7.5)	Good (pH2-7.5)
Retention	Average	Average	Long (1.3 times)	Very long (2 times)	Average

Characteristics of ODS phases are showed in the above table. Develosil ODS-UG is the most stable under alkaline conditions, and can be used under pH1 to pH10. Develosil ODS-HG is the most stable under acidic conditions, and can be used even under 0.5% TFA. Develosil ODS-MG shows medium performance and suitable for all samples. Develosil ODS-SR shows long retention, and suitable for LC/MS because organic in the mobile phase increase and sensitivity increases. Develosil PAHS is a real polymeric ODS, and has the highest steric selectivity.

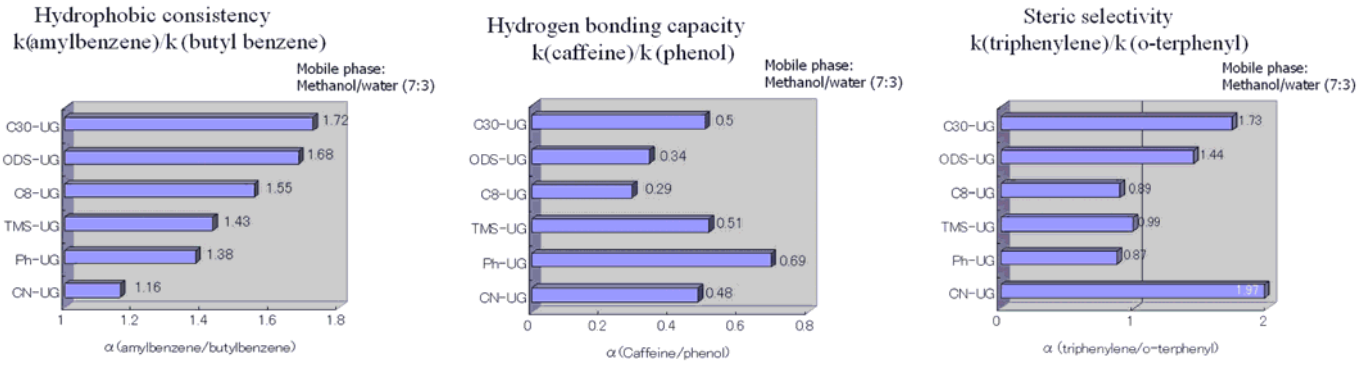


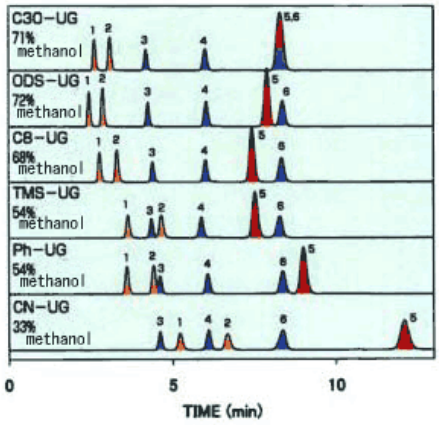
Conditions
Colum size: 150 x 4.6 mm i.d.
Mobile phase: Methanol/water (75:25)
Temperature: 30C
Detection: UV@254nm
Sample:
1=Butylbenzene
2=o-Terphenyl
3=Amylbenzene
4=Triphenylene

UG series phases

All phase are monomerically bonded and endcapped on the same silica base. We can use and compare with phases which has only different ligand each other.

	Particle size	Ligand	End-capping (TMS)	Carbon content (%)	Silica		
					Surface area (m2/g)	Pore volume (mL/g)	Pore diameter (nm)
Develosil C30-UG	3 um, 5 um	-Si (CH3)2C30H61	Yes	18	300	1.15	14
Develosil ODS-UG	3 um, 5 um	-Si (CH3)2C18H37	Yes	18	300	1.15	14
Develosil C8-UG	3 um, 5 um	-Si (CH3)2C8H17	Yes	11	300	1.15	14
Develosil TMS-UG	3 um, 5 um	-Si (CH3)3	Yes	4.5	300	1.15	14
Develosil Ph-UG	3 um, 5 um	-Si (CH3)2C6H5	Yes	8	300	1.15	14
Develosil CN-UG	5 um	-Si (CH3)2 C3H6CN	Yes	7	300	1.15	14





Comparison of chromatograms

Conditions
Column size: 150 x 4.6 mm i.d.
Mobile phase: Methanol/water (methanol parcent described in figure) (Retention time of peak 6 was adjusted at 8.5 min.)
Flow rate: 1.0 mL/min
Temperature: 30C
Detection: UV@254nm
Sample
1=Methyl parabene
2=Ethyl parabene
3=Benzene
4=Toluene
5=Naphthalene
6=Ethylbebzene

Develosil silica gel

	Particle size	Surface area (m2/g)	Pore volume (mL/g)	Pore diameter (nm)
Develosil 30	3 um, 5 um,15/30um	700	0.5	3
Develosil 60	3 um, 5 um,15/30um	500	0.75	6
Develosil 100	3 um, 5 um,15/30um	350	1.0	12
Develosil SILICA-HILIC(I)	3 um, 5 um	300	1.15	14

Develosil 30, 60 and 100 silica gels are type A. But Develosil SILICA-HILIC(I) is type B and also for HILIC mode.

Expression of stationary phase

Develosil + stationary phase name (ODS-UG or C8-UG) + particle size (μm) e.g. Develosil ODS-HG-5

Size of Develosil column

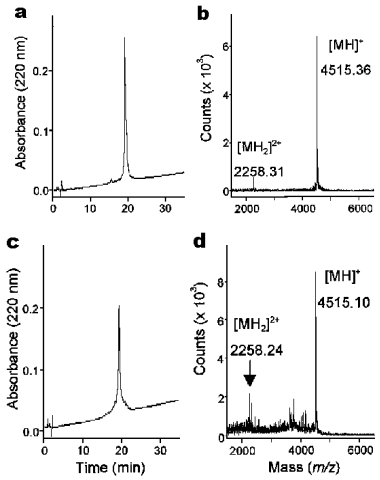
Capillary column (0.075 mm i.d.) to preparative column (28 mm I.d. for 5 um particle, 50 mm i.d. for 15/30 um particle) are available.

Available Inner diameters are shown as follows:

0.075 mm, 0.15 mm, 0.3 mm, 0.5 mm, 1.0 mm, 1.5 mm, 2.0 mm, 3.0 mm, 4.0 mm, 4.6 mm, 6.0 mm, 8.0 mm, 10 mm, 20 mm, 28 mm, 50mm

Applications

Separation of amyloid peptide (LC/MS(3))



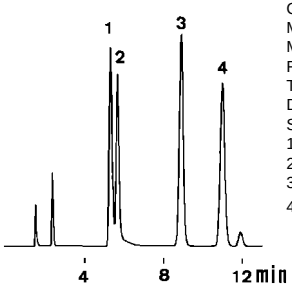
Data：Hiroyuki Fukuda, PE Biosystems Japan

Column: Develosil **ODS-UG-3** 50 x 2.0 mm
Mobile phase:
A) 0.1% NH4OH pH10
B) Acetonitrile

Time	0 min	35 min
%B	15%	36%

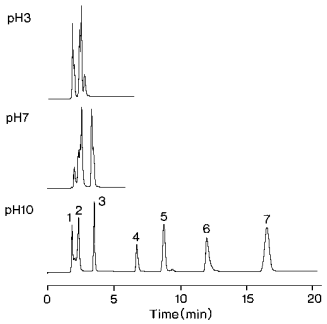
Flow rate: 0.2 mL/min
Detection: UV@220 nm and MALDI-TOF-MS
Sample:Amyloid peptide
DAEFRHDSGYEVHHQKLVFFAEDVGSNKG
AIIGLMVGGVVIA (a,b:synthetic)

Separatin of tricyclic antidepressants



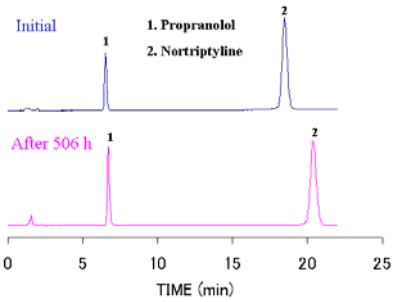
Column: Develoisl **ODS-UG-5** 150 x 4.6 mm
Mobile phase:
Methanol/0.025MKH2PO4,pH7.5(80:20)
Flow rate: 1.0 mL/min
Temperature: 30 C
Detection: UV@254nm
Sample:
1. Doxepin
2. Nortriptyline
3. Amitriptyline
4. Trimipramine

Separation of basic compounds (effect of pH of a mobile phase)



Column: Develosil **ODS-UG-5** 150 x 4.6 mm
Mobile phase: Methanol/20mM sodium phosphate pH3.0, pH7.0, pH10 (35:65)
Flow rate: 1.0 mL/min
Temperature: 30**℃**
Detection: UV @254 nm
sample:
1. Pyridoxine
2. Amiloride
3. Pyridine
4. Benzylamine
5. Procainamide
6. N-Methylbezylamine
7. N-Acethylprocainamide

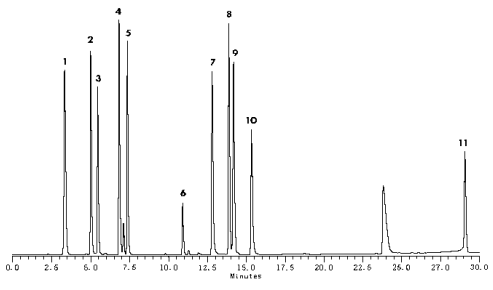
Separatin of tricyclic antidepressant (Stability test)



Column: Develosil **ODS-UG-5** 4.6x150 mm + 4.0x20mm guard column
Mobile phase: 0.05M Pyrrolidine-Hydrochloric acid pH11.5/acetonitrile, 50/50
Flow rate: 1.0 mL/min
Temperature: 30**℃**
Detection: UV @215 nm
Sample volume: 2 uL

	Peak Number	USP Tailing Factor
Initial	1.Propranolol	1.2
	2.Nortriptyline	1.1
After 506 h	1.Propranolol	1.2
	2.Nortriptyline	1.2

Separation of color additives

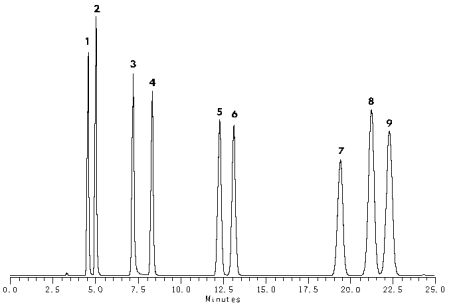


Column: Develosil ODS-UG-5 150 x 4.6 mm
Mobile phase:
A) 10mM ammonium acetate pH6.0
B) Acetonitrile

Time	0 min	30 min
%B	5%	100%

Flow rate: 1.0 mL/min
Temperature: 40**℃**
Detection: UV @254 nm
sample:
1.Tertrazine)
2.Amaranth
3.Indigocarmine
4.Nwe coccine
5.Sunset yellow FCF
6.Fast green
7.Erythrosine B
8.Acid red
9.Phloxine B
10.Rose bengal
11.Brilliant green

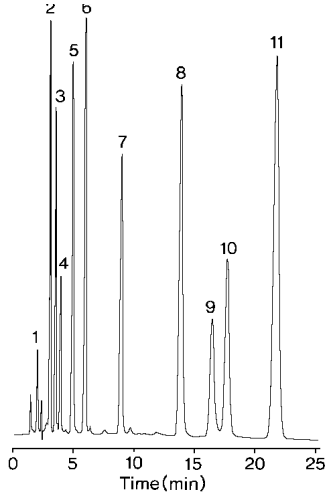
Separation of food preservatives



Column: Develosil **ODS-UG-5** 250 x 4.6 mm
Mobile phase: Acetonitrile/20 mM sodium acetate (pH4.2)
Flow rate: 1.0 mL/min
Temperature: 30**℃**
Detection: UV @254 nm
Sample:
1.Benzoic acid (BA)
2.Sorbic acid (SOA)
3.Dehydroacetic acid (DHA)
4.p-Hydroxybenzoic acid ethyl ester
5.p-Hydroxybenzoic acid iso-propyl ester
6.p-Hydroxybenzoic acid n-propyl ester
7.p-Hydroxybenzoic acid sec-butyl ester
8.p-Hydroxybenzoic acid iso-butyl ester
9.p-Hydroxybenzoic acid n-butyl ester

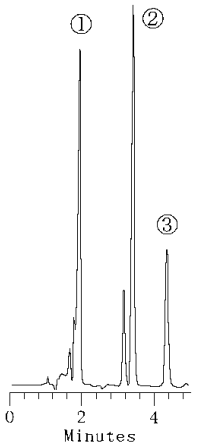
Applications

Separation of water-soluble vitamins



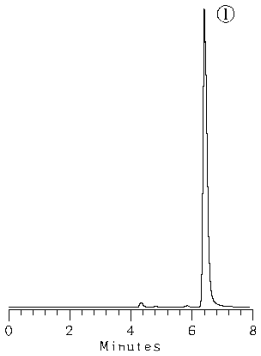
Column: Develosil **ODS-UG-5** 150 x 4.6 mm
Mobile phase: Acetonitrile/5mM 1-hexansulfonic acid sodium salt + 20mM phosphate acid(8:92)
Flow rate: 1.0 mL/min
Temperature: 40**℃**
Detection: UV @210 nm
sample:
1. Ascorbic acid
2. Nicotinic acid
3. Nicotinamide
4. Calcium (+) - pantothenate
5. Pyridoxal hydrochloride
6. Pyridoxine hydrochloride
7. Pyridoxamine hydrochloride
8. Thiamin
9. Folic acid
10. (+)-Biotin
11. Riboflavin

Separation of steroids



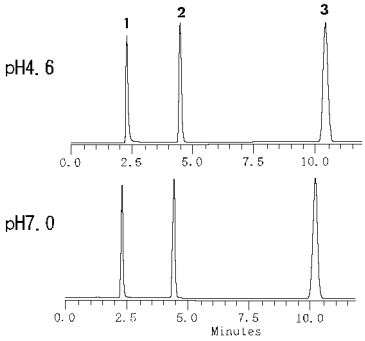
Column: Develosil **ODS-UG-5** 150 x 4.6 mm
Mobile phase: Acetonitrile/water (55:45)
Flow rate: 1.0 mL/min
Temperature: 40**℃**
Detection: UV @254 nm
sample:
1. Estriol
2. **β**-Estradiol
3. Estron

Separation of berberine chloride



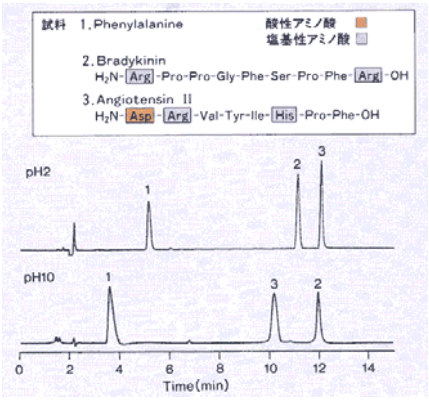
Column: Develosil **ODS-UG-5** 150 x 4.6 mm
Mobile phase: Acetonitrile/10mM NaH2PO4 + 100mM NaClO4 (40:60)
Flow rate: 1.0 mL/min
Temperature: 40**℃**
Detection: UV @340 nm
Sample:
1.Berberine chloride

Separation of fungicides



Column: : Develosil **ODS-UG-5** 4.6 x 150 mm
Mobile phase: Acrtonitrile/20mM sodium phosphate (pH4.6, pH7.0) (60:40)
Flow rate: 1.0 mL/min
Temperature:30**℃**
Detection: UV @254 nm
Sample:
1.Thiabendazole (TBZ)
2.o-Phenylphenol (OPP)
3.Diphenyl (DP)

Separation of peptides (effect of pH of mobile phase)



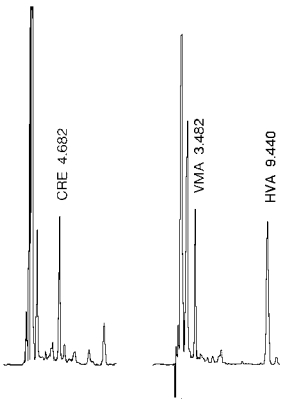
Column: Develosil **ODS-UG-5** 150 x 4.6 mm
Mobile phase:
A) 0.1% Trifluoracetic acid pH2.0, or 30mM Ammonium acetate pH10
B) Acetonitrile

Time	0 min	20 min
%B	10%	50%

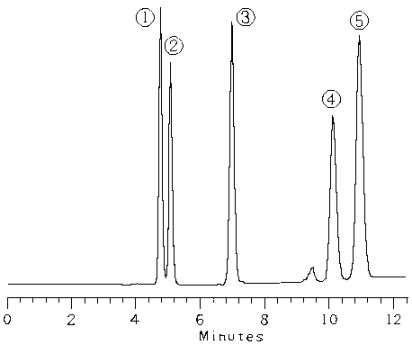
Flow rate: 1.0 mL/min
Temperature: 30**℃**
Detection: UV @215 nm
sample:
1. Phenylalanine
2. Bradykinin
3. Angiotensin **II**

Separation of hippuric and methylhippuric acids

Separation of creatinine, VMA and HVA



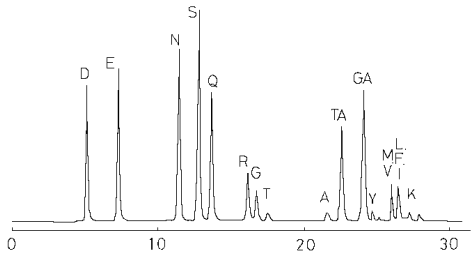
Column: Develosil **ODS-HG-5** 250 x 4.6 mm
Mobile phase: Acetonitrile/3mM 1-hexansulfonic acid sodiumsalt + 50mM potassium phosphate + EDTA10mg/L pH2.0 (93:1000)
Flow rate: 1.0 mL/min
Temperature: 65**℃**
Detection: Electoricchemical 5100A, ESA (USA), Detector1 0.2V, Detector2 0.26V, Guard cell 0.31V, UV @235 nm
sample:
1. Creatinine
2. VMA
3. HVA



Column: Develosil **ODS-HG-5** 150 x 4.6 mm
Mobile phase: Acetonitrile/20mM phosphate buffer(pH2.7) + 10mM **β**-cyclodextrin (20:80)
Flow rate: 1.0 mL/min
Temperature: 40**℃**
Detection: UV @210 nm
sample:
1. Mandelic acid
2. Hippuric acid
3. o-Methylhippuric acid
4. p-Methylhippuric acid
5. m-Methylhippuric acid

Applications

Separation of amino acids (OPA)

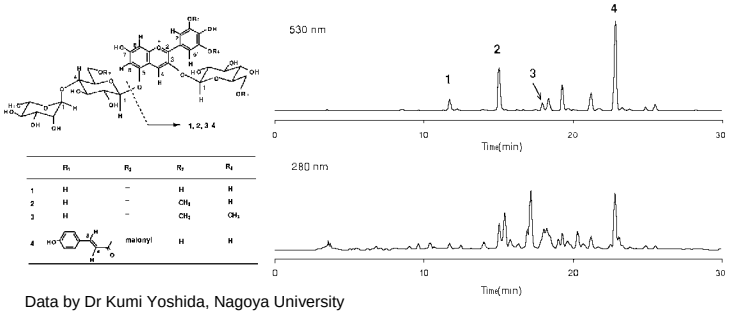


Data:Tetsuhisa Goto, National Food Research Institute
Column: Develosil **ODS-HG-5** 150 x 4.6 mm + 10 x 4.0 mm (guard)
Mobile phase:
A) 5 mM Citrate buffer (pH6.0)/acetonitrile (19:1)
B) 5 mM Citrate buffer (pH6.0)/acetonitrile (3:7)

Time	0 min	5 min	20 min	25 min
%B	5%	12%	22%	95%

Flow rate: 1.0 mL/min
Temperature:40**℃**
Detection: Ex@340nm、Em@450nm

Separation of anthocyanins



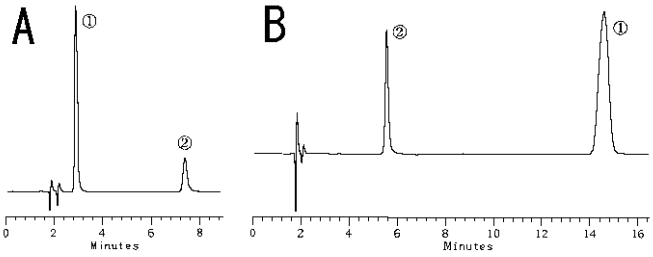
Data by Dr Kumi Yoshida, Nagoya University

Column: Develosil **ODS-HG-5** 250 x 4.6 mm
Mobile phase:
A) 0.5% TFA
B) TFA/acetonitrile(0.5:99.5)

Time	0 min	30 min
%B	10%	30%

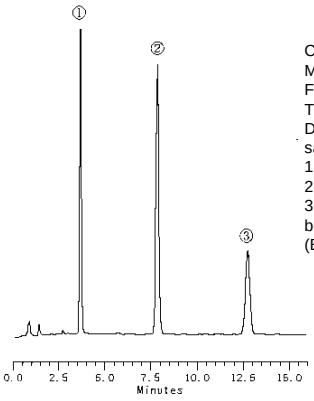
Flow rate: 1.0 mL/min
Temperature:40**℃**
Detection: UV@530 nm and 280 nm
Sample:Extract of purplish blue spicate flower petal of *Muscari armeniacum*

Separation of agricultural chemicals 1



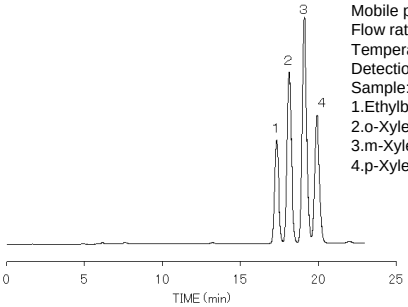
Column: Develosil **ODS-HG-5** 150 x 4.6 mm
Mobile phase:
A) Acetonitrile/20 mM phosphoric acid (10:90)
B) Acetonitrile/5 mM octansulfonic acid sodium salt + 20 mM phosphoric acid (10:90)
Flow rate: 1.0 mL/min
Temperature: 40**℃**
Detection: UV @250 nm
sample:
1. Copper 8-quinolinolate
2. Methyl sulfanilycarbamate (Asulam)

Separation of agricultural chemicals 2



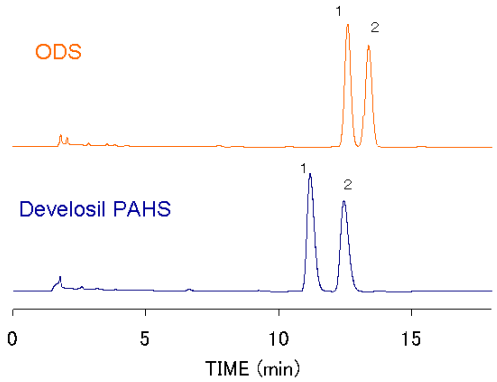
Column: Develosil **ODS-HG-5** 150 x 4.6 mm
Mobile phase: Acetonitrile/water (55:45)
Flow rate: 1.0 mL/min
Temperature: 40**℃**
Detection: UV @230 nm
sample:
1. Bis(dimethylthiocarbamoyl)disulfide (Thiram)
2. Iprodione
3. 0,0-Di-isopropyl S-2-benzensulphonamidoethylphosphorodithioate (Bensulide)

Separation of xylenes



Column: Develoisl **PAHS-5** 250 x 4.6 mm
Mobile phase: Methanol/water(75:25)
Flow rate: 1.0 mL/min
Temperature: 20 C
Detection: UV@254nm
Sample:
1.Ethylbenzene
2.o-Xylene
3.m-Xylene
4.p-Xylene

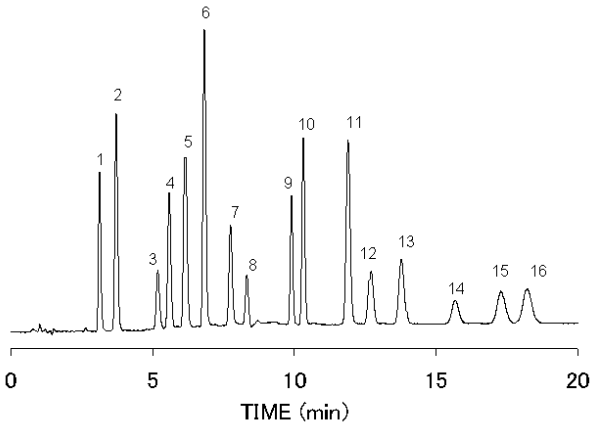
Separation of vitamin D2 and D3



Column: Develoisl **PAHS-5** 250 x 4.6 mm
ODS 250 x 4.6 mm
Mobile phase: Acetonitrile
Flow rate: 1.0 mL/min
Temperature: 30 C
Detection: UV@254nm
Sample:
1.Vitamin D2
2.Vitamin D3

Applications

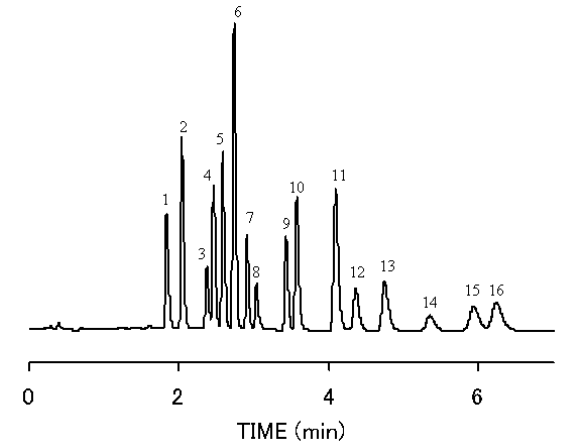
Separation of polyaromatichydrocarbons (PAHs)



Column: Develosil **PAHS-5** 150 x 4.6 mm
Mobile phase:
A)Water
B)Methanol

Time	0 min	3.4 min	8.1 min	20min
%B	80%	80%	100%	100%

Flow rate: 1.5 mL/min
Temperature: 30 C
Detection:UV@254nm
Sample:1)Naphthalene 2)Acenaphthylene 3)Acenaphthene 4)Fluorene 5)Phenanthrene 6)Anthracene 7)Fluoranthene 8)Pyrene 9)Benzo (a) anthracene 10)Chrysene 11)Benzo (b) fluoranthene 12)Benzo (k) fluoranthene 13)Benzo (a) pyrene 14)Dibenzo (a,h) anthracene 15)Benzo (g,h,i) perylene 16)Indeno (1,2,3-cd) pyrene

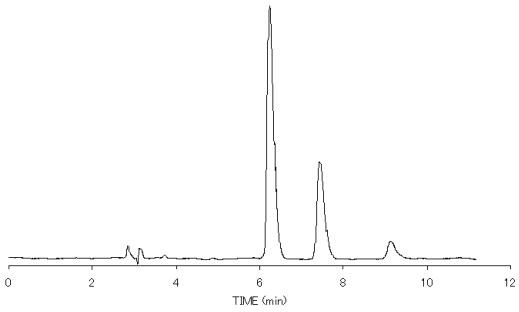


Column: Develosil **PAHS-3** 75 x 4.6 mm (3 um particle)
Mobile phase:
A)Water
B)Methanol

Time	0 min	0.5 min	2.5 min	7min
%B	70%	70%	100%	100%

Flow rate: 1.5 mL/min
Temperature: 30 C
Detection:UV@254nm
Sample:1)Naphthalene 2)Acenaphthylene 3)Acenaphthene 4)Fluorene 5)Phenanthrene 6)Anthracene 7)Fluoranthene 8)Pyrene 9)Benzo (a) anthracene 10)Chrysene 11)Benzo (b) fluoranthene 12)Benzo (k) fluoranthene 13)Benzo (a) pyrene 14)Dibenzo (a,h) anthracene 15)Benzo (g,h,i) perylene 16)Indeno (1,2,3-cd) pyrene

Separation of benzalkonium chloride



Column: Develosil **CN-UG-5** 250 x 4.6 mm
Mobile phase: Methanl/100mM CH3COONa, pH5.5=70:30
Flow rate: 1.0 mL/min
Temperature: 30 C
Detection: UV@265nm
Sample:
1=benzalkonium chloride