5 MCI GEL™ Analytical and preparative chromatography columns and materials for pharmaceutical applications

○Polymeric partition chromatography columns and materials MCI GEL™ CHP series

Separation mechanism of CHP series

High performance liquid chromatography relies on one of the following physical phenomena for efficient separation of solutes: partition, adsorption, size exclusion, or ion exchange. Of these, partition chromatography is the most commonly used method, and it separates solutes based on their difference in partitioning between a stationary phase and a mobile phase. This technique has currently become the mainstay in industry for the separation of organic compounds such as pharmaceuticals, agricultural chemicals, and other intermediates. Practically, partition chromatography can be performed in two different modes depending on the relative polarities of the stationary and mobile phases. In the normal phase (NP) mode, the mobile phase is less polar than the stationary phase while the situation is reversed in the reverse phase (RP) mode, where the mobile phase is significantly more polar than the stationary phase.

MCI GEL™ specializes in polymer-based packing materials. The use of polymer-based columns has become more widespread thanks to the many advantages of the polymer matrix like excellent selectivity, the absence of specific adsorption which is found commonly with silica-based packing, operability in a wide pH range and good chemical stability due to the inert nature of polymeric materials. The MCI GEL™ partition chromatography columns are based on a polystyrene and polymethacrylate porous polymer. As RP columns, they are applied to the separation of a wide variety of organic compounds, both in the isocratic and gradient elution mode. The compounds include peptides, insulin, small molecule APIs, nutraceutical compounds, water-soluble vitamins and nucleotides. As NP columns, they are used in the separation of various carotenoids, fat-soluble vitamins, steroids, and food additives. These columns tolerate various organic solvents like hexane, heptane, methylene chloride, and alcohols.
As NP columns, they are used in the separation of various carotenoids, fat-soluble vitamins, steroids, and food additives. Various organic solvents like Hexane Heptane, methylene chloride and alcohols can be used.

The MCI GEL™ packing materials are based on the same chemistries offered in the Diaion™ and Sepabeads™ synthetic adsorbent resins. These polymer chemistries, like Diaion™ HP series and Sepabeads™ SP series, are widely used and documented in the biopharmaceutical industry for fermentation extraction, the food industry and in industrial chromatographic separations. The MCI GEL™ packing materials are available as packed columns for analytical applications, and as bulk packing materials for analytical, preparative and production chromatography applications.

●Description of MCI GEL™ columns and materials

MCI GEL™ CHP20/C04

- CHP: Matrix type
- 20: Particle size
- C: C=Column, P=Material

CHP column series

Analytical and preparative chromatography columns and materials for pharmaceutical applications

MCI GEL™ CHP series are suitable for RP and NP chromatography. There are four kinds of columns of various hydrophobicities; porous polystyrene, modified porous polystyrene, polymethacrylate, and modified porous polymethacrylate. This range of packing materials offers tremendous scope for a proper selection of columns based on the properties of the target compounds.

Polystyrene packing: MCI GEL™ CHP20/C04, CHP20/C10
Modified polystyrene packing: MCI GEL™ CHP07/C04, CHP07/C10, CHK40/C04
Polymethacrylate packing: MCI GEL™ CMG20/C10
Modified polymethacrylate packing: MCI GEL™ CHPOD/C04, CHK45/C05

The hydrophobicities of the columns are in the following orders:

MCI GEL™ CHP07/C04, C10 > CHP20/C04, C10 > CHPOD/C04 ≥ ODS columns ≥ CMG20/C04, C10

Polymer columns for HPLC, with their superior chemical resistance, can be used with various mobile phases of broad pH range, acidic through alkaline. They have the following advantages due to their high hydrophobicities:

1) In reverse phase chromatographic methods to separate acidic or alkaline compounds, eluents that can suppress the ionic properties of such compounds are generally used. Polymer columns can be applied in these cases where ODS columns would be unsuitable.
2) Some extremely hydrophilic compounds, e.g., oligosaccharides, can be separated using strongly hydrophobic CHP07/C04 or CHP07/C10 columns.
3) Polymer columns can be washed with acidic and/or basic solutions in case of contamination.

Polymethacrylate columns, CMG20/C04 and CMG20/C10, can be applied both for reverse phase and normal phase chromatography.

Modified polystyrene packing, CHK40/C04, is a mixed-mode type material; both hydrophobic and hydrophilic interactions occur between the packing material surface and the analytes. This material is useful for compounds that are difficult to separate using existing ODS or other polymer-based columns. This column is also used in the normal phase mode and shows a unique separation profile.

All polymeric columns exhibit superior stability and yield in comparison to ODS columns, which may have free silanol groups even when end-capping agents have been used.

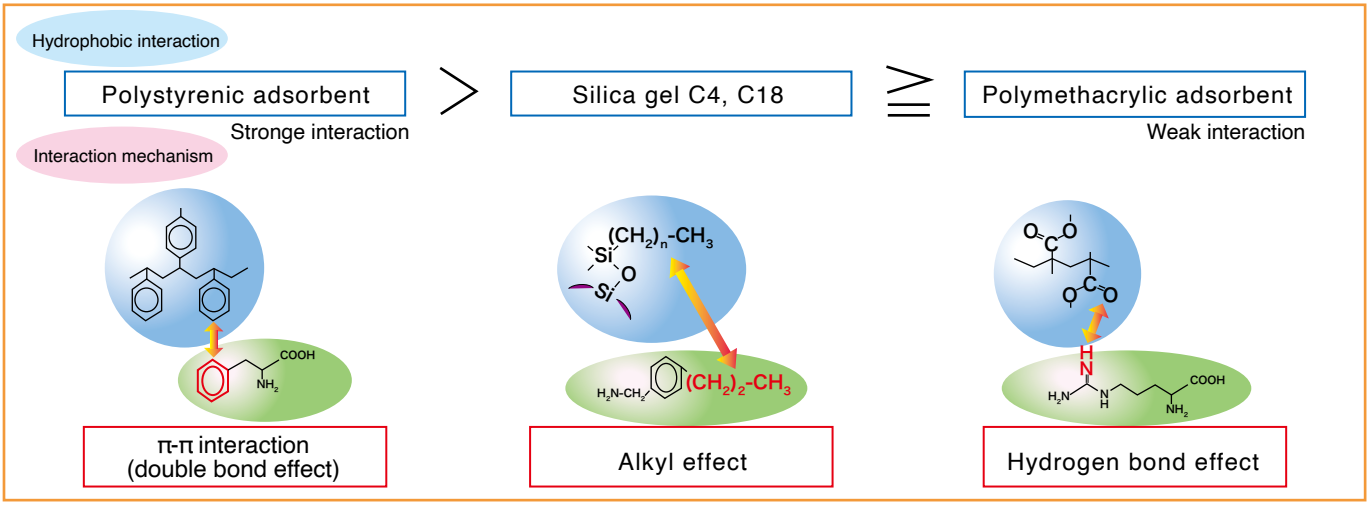
Column list

●CHP column series

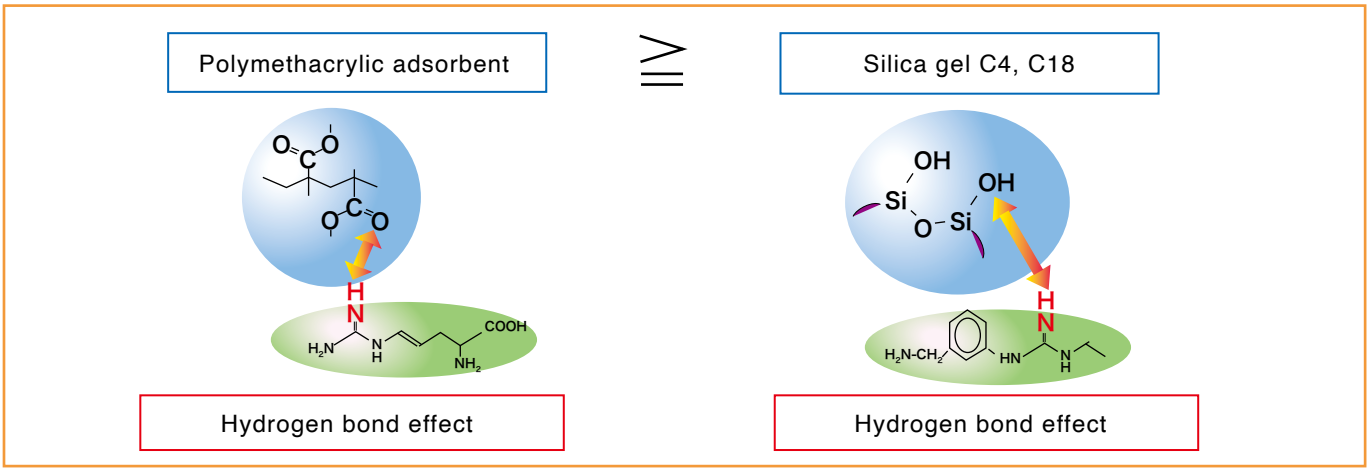
Matrix Type	Functinal group	Product name	Particle size [μm]	Column size [mm I.D.×mm]	pH range	USP
Styrene Divinylbenzene	None	CHP20/C04	4	4.6×150 20×150	Full range	L21
		CHP20/C10	10	4.6×150 4.6×250 10×250 20×150 20×250		
	Br	CHP07/C04	4	4.6×150 20×200		
		CHP07/C10	10	4.6×150 4.6×250 10×150 20×150 20×250		
	Cation exchange group	CHK40/C04	4	4.6×150		
Methacrylates	None	CMG20/C04	4	4.6×150 20×150	2～12	
		CMG20/C10	10	4.6×150 4.6×250 10×250 20×150 20×250		
	C18	CHPOD/C04	4	4.6×150 20×200		
	Weak cation exchange group	CHK45/C05	5	4.6×150		

*CHP20/C04, CHP20/C10: USP classification is L21

Retentiveness in reverse phase mode



Hydrophobic interaction Interaction mechanism

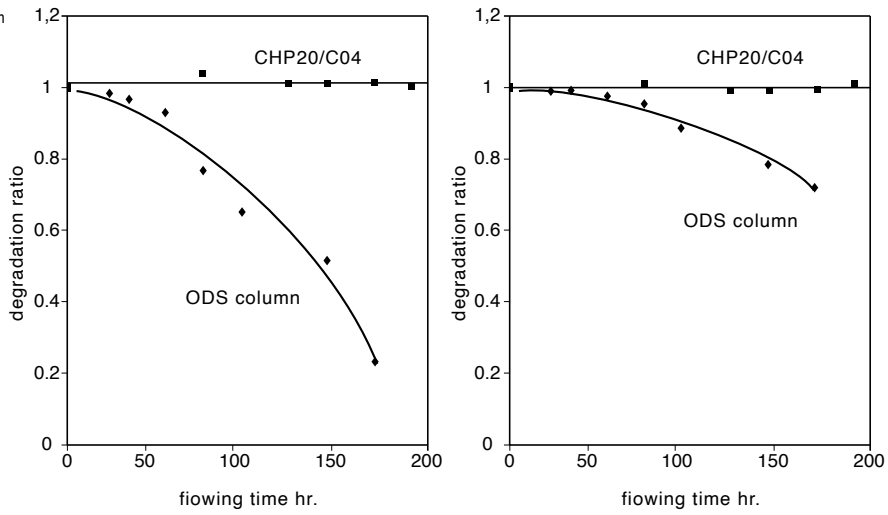


Durability of polymeric column

The polymeric RP columns are chemically stable. Specifically, the columns have resistance to an alkaline eluent. The following graphs demonstrate stability of the polymeric columns. After feeding a solution of pH 12 into the MCI GEL™ CHP20/C04, there is no change of column performance.

Fig. 5-1 Column durability at pH12 comparison between CHP20/C04 and an ODS column

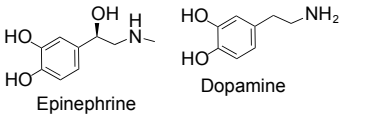
Conditions
Column : MCI GEL™ CHP20/C04 4.6mmI.D × 150mm
Eluent : 20mM Na_2HPO_4 pH12/CH3CN/=60/40
Flow rate : 0.4mL/min
Column temp. : 25°C
Detection : 254nm
Sample : 1000ppm Dimethyl phthalate 5μL

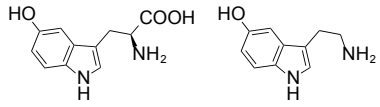


Application data of CHP series

Fig. 5-2 Separation of catecholamines

Conditions
Column : MCI GEL™ CHP20/C04
4.6mm I.D.×150mm
Eluent : 50mM Na-phosphate pH2.0,
1.5% Hexanesulfonic acid /
CH_3CN=80/20
Flow rate : 0.25mL/min
Column temp. : ambient
Detection : 280nm
Sample : 1. Epinephrine
2. Dopamine
3. 5-Hydroxy tryptophan
4. Serotonin
5. Tryptophan





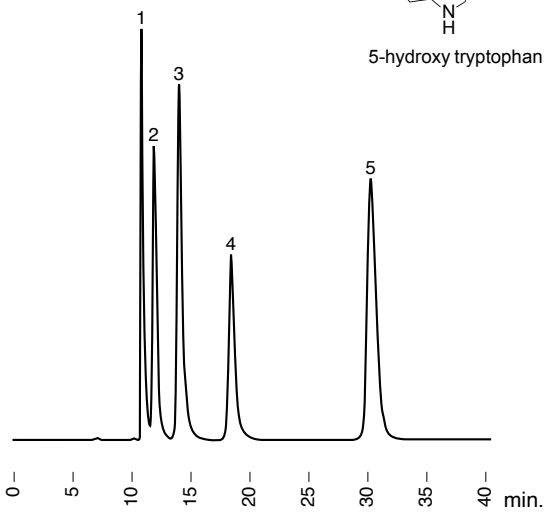
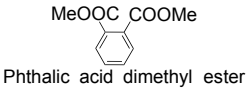
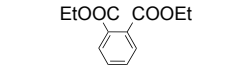


Fig. 5-3 Separation of phthalic acid esters

Conditions
Column : MCI GEL™ CHP20/C04
4.6mm I.D.×150mm
Eluent : H_2O/CH_3CN=50/50
Flow rate : 0.75mL/min
Column temp. : 60°C
Detection : 254nm
Sample : 1. Dimethyl phthalate
2. Diethyl phthalate
3. Dipropyl phthalate





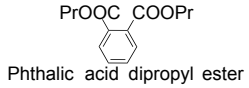


Fig. 5-4 Purine alkaloids

Conditions
Column : MCI GEL™ CHP20/C04
4.6mm I.D.×150mm
Eluent : H_2O/CH_3CN=10/90
Flow rate : 0.4mL/min
Column temp. : 25°C
Detection : 275nm
Sample : 1.Theophylline
2.Theobromine
3.Caffeine

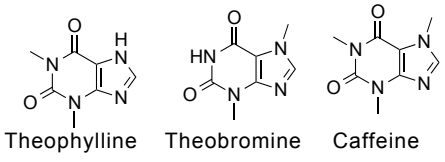
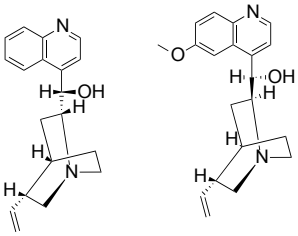
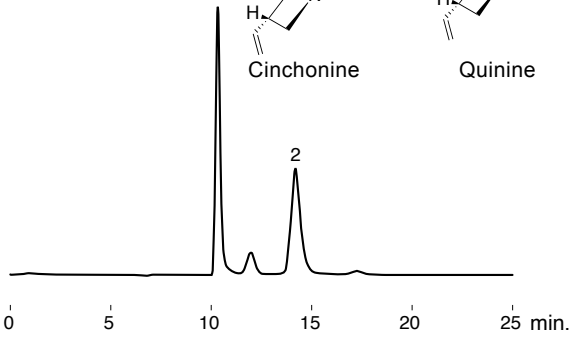


Fig. 5-5 Cinchona alkaloids

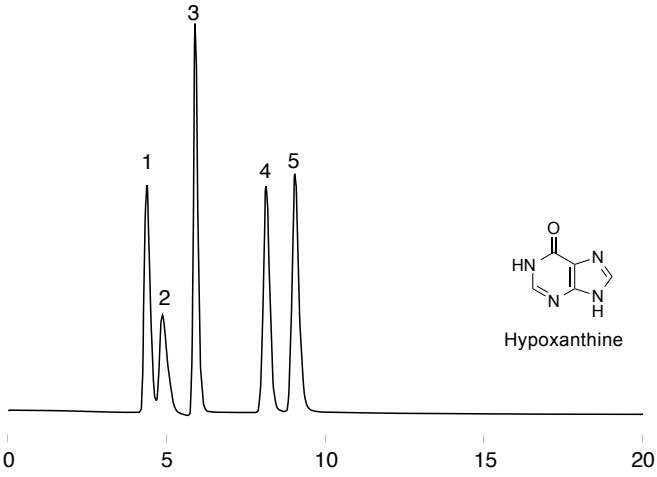
Conditions
Column : MCI GEL™ CHP20/C04
4.6mm I.D.×150mm
Eluent : 0.1M NaH_2PO_4 pH2.0
CH_3CN=88/12
Flow rate : 0.3mL/min
Column temp. : 25°C
Detection : 275nm
Sample : 1.Cinchonine
2.Quinine



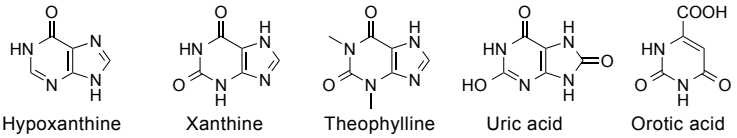


Application data of CHP series

Fig. 5-6 Uric acid and related compounds

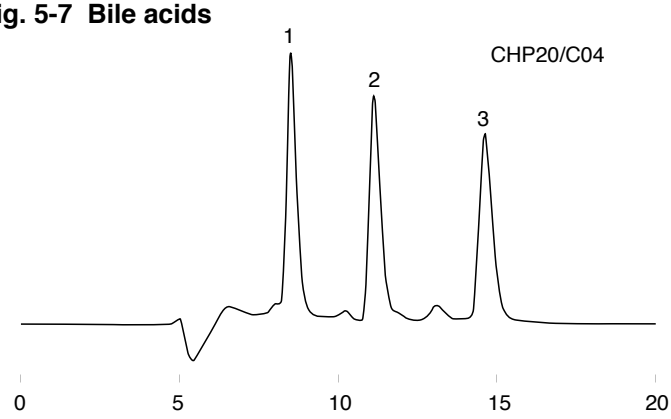


Conditions
Column : MCI GEL™ CHP20/C04
4.6mm I.D.×150mm
Eluent : 10mM TBA/CH3CN=75/25
Flow rate : 0.4mL/min
Column temp. : 25°C
Detection : 284nm
Sample : 1.Hypoxanthine
2.Xanthine
3.Theophylline
4.Uric acid
5.Orotic acid

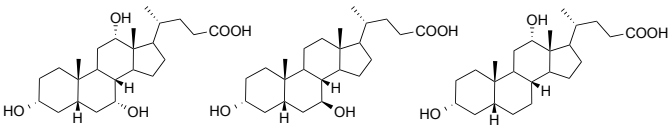


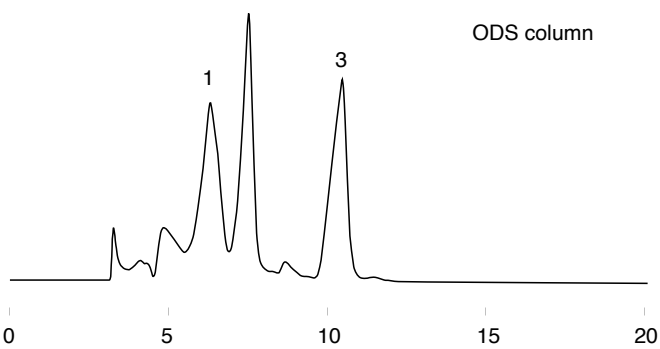
Comparison with an ODS column

Fig. 5-7 Bile acids



Conditions
Column : MCI GEL™ CHP20/C04
4.6mm I.D.×150mm
Eluent : 50mM NaH_2PO_4 pH2.0
/CH_3CN=40/60
Flow rate : 0.3mL/min
Column temp. : 25°C
Detection : 210nm
Sample : 1.Cholic acid
2.Ursodeoxycholic acid
3.Deoxycholic acid

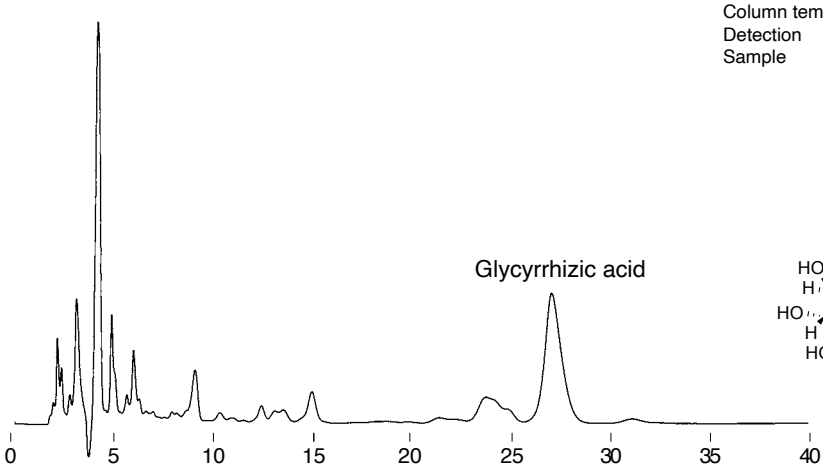


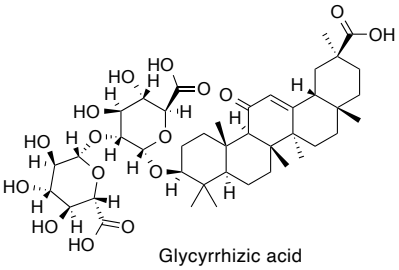


Conditions
Column : ODS column (5μm)
4.6mm I.D.×150mm
Eluent : 50mM NaH_2PO_4 pH6.0
/CH_3CN=40/60
Flow rate : 0.3mL/min
Column temp. : 25°C
Detection : 210nm
Sample : 1.Cholic acid
2.Ursodeoxycholic acid
3.Deoxycholic acid

Fig. 5-8 Glycyrrhizae radix

Conditions
Column : MCI GEL™ CHP20/C04 4.6mm I.D.×150mm
Eluent : 2.06% acetic acid/CH_3CN =63/37
Flow rate : 0.5mL/min
Column temp. : 45°C
Detection : 254nm
Sample : Extract of glycyrrhizae radix

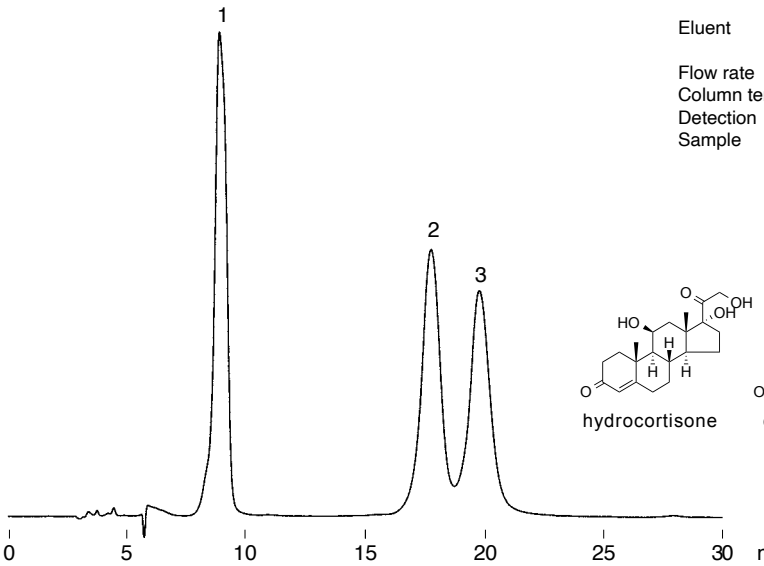


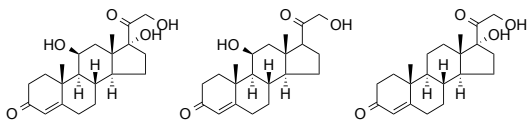


Glycyrrhizic acid

Fig. 5-9 Adrenal cortex hormones

Conditions
Column : MCI GEL™ CHP20/C04 4.6mm I.D.×150mm
Eluent : H_2O/CH_3CN
: 60/40
Flow rate : 0.5mL/min
Column temp. : 45°C
Detection : 280nm
Sample : 1.Hydrocortisone
2.Corticosterone
3.11-Deoxycortisol

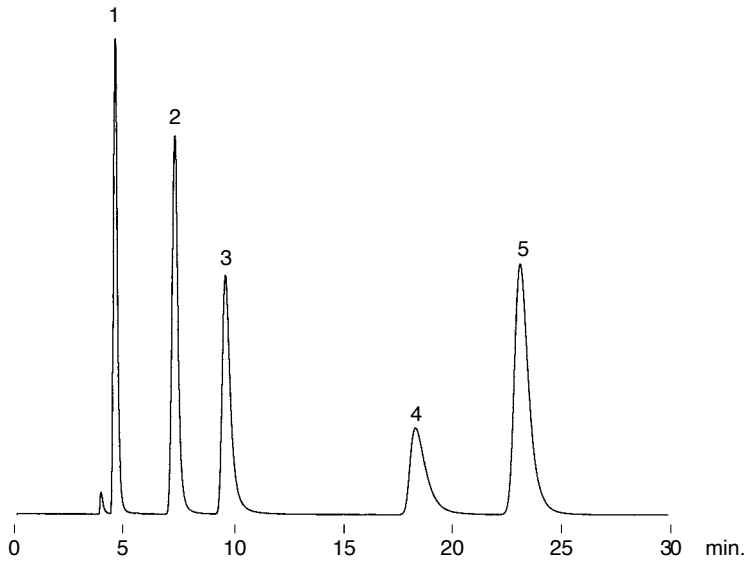




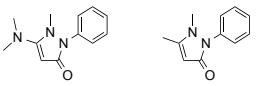
hydrocortisone corticosterone 11-deoxycortisol

Application data of CHP series

Fig. 5-10 Ingredients of medicine



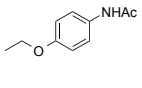
Conditions
Column : MCI GEL™ CMG20/C04
4.6mm I.D.×150mm
Eluent : 50mM phosphoric acid(pH2.0)/CH_3OH
=60/40
Flow rate : 0.5mL/min
Column temp. : 45°C
Detection : 254nm
Sample : 1.4-Dimethylaminoantipyrine
2.Antipyrine
3.Caffeine
4.Aspirin
5.Phenacetin


Dimethylaminoantipyrine
Aminopyrine

Antipyrine

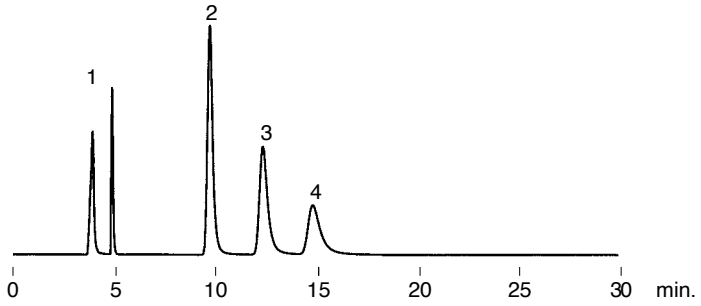

Caffeine


Aspirin

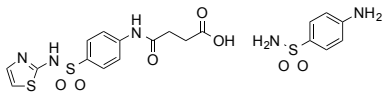

Phenacetin

Comparison with an ODS column

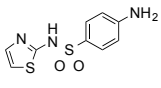
Fig. 5-11 Sulfa drugs

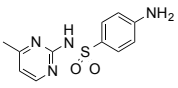


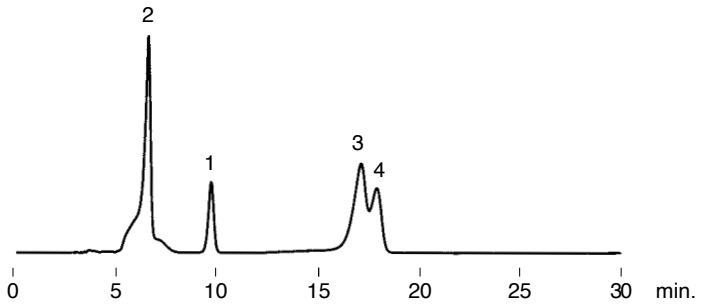
Conditions
Column : MCI GEL™ CMG20/C04
4.6mm I.D.×150mm
Eluent : 20mM phosphate pH6.8/CH_3CN
=82/18
Flow rate : 0.5mL/min
Column temp. : 45°C
Detection : 254nm
Sample : 1.Succinylsulfathiazole
2.Sulfanilamide
3.Sulfathiazole
4.Sulfamerazine


Succinylsulphathiazole

Sulfanilamide


sulphathiazole


Sulfamerazine

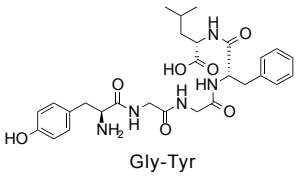


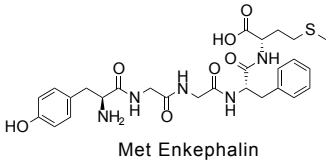
Conditions
Column : ODS column
4.6mm I.D.×150mm
Eluent : 20mM phosphate pH6.8/CH_3CN
=90/10
Flow rate : 0.5mL/min
Column temp. : 45°C
Detection : 254nm
Sample : 1.Succinylsulfathiazole
2.Sulfanilamide
3.Sulfathiazole
4.Sulfamerazine

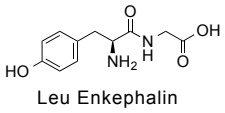
Application data of CHP series

Fig. 5-12 Peptides

Conditions
Column : MCI GEL™ CMG20/C04 4.6mm I.D.×150mm
Eluent : 0.1%TFA/CH_3CN =70/30
Flow rate : 0.5mL/min
Column temp. : 25°C
Detection : 220nm
Sample : 1.Gly-Tyr
2.Met Enkephalin
3.Leu Enkephalin
4.Angiotensin II


Gly-Tyr


Met Enkephalin


Leu Enkephalin

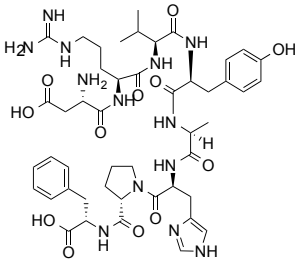

Angiotensin II

Fig. 5-13 Proteins

Conditions
Column : MCI GEL™ CMG20/C04 4.6mm I.D.×150mm
Eluent : A;0.05%TFA/CH_3CN =80/20
B;0.05%TFA/CH_3CN =20/80
A→B 30min.linear
Flow rate : 0.5mL/min
Column temp. : 25°C
Detection : 280nm
Sample : 1.Ribonuclease A
2.Cytochrome c
3.α-Chymotrypsinogen A

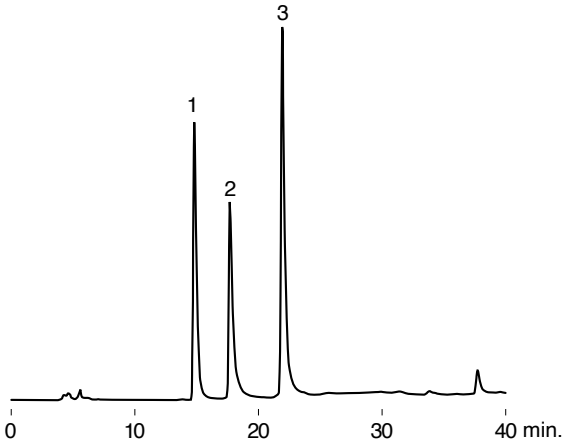
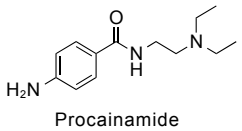


Fig. 5-14 Procainamide, Procaine

Conditions
Column : MCI GEL™ CMG20/C04 4.6mm I.D.×150mm
Eluent : 20mM phosphate pH7.2/CH_3CN =65/35
Flow rate : 0.5mL/min
Column temp. : 45°C
Detection : 254nm
Sample : 1.Procainamide
2.Procaine


Procainamide

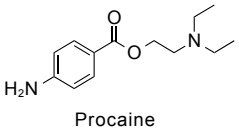
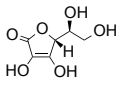
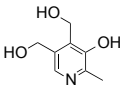
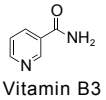

Procaine

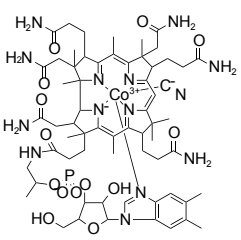
Fig. 5-15 Water-soluble vitamins

Conditions
Column : MCI GEL™ CMG20/C04 4.6mm I.D.×150mm
Eluent : 8mM Na_2HPO_4 pH7.0/CH_3CN =85/15
Flow rate : 0.5mL/min
Column temp. : 25°C
Detection : 254nm
Sample : 1.Vitamin C
2.Vitamin B6
3.Vitamin B3
4.Vitamin B12


Vitamin C


Vitamin B6

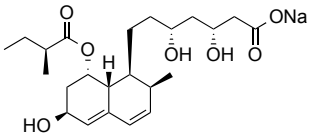

Vitamin B3


Vitamin B12

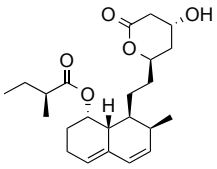
Application data of CHP series

Fig. 5-16 Pravastatin sodium

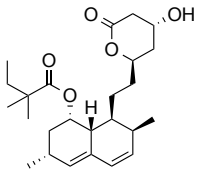
Conditions
Column : MCI GEL™ CHP20/C10 (10μm 250 ×4.6mm I.D.) and ODS (10μm 250 ×4.6mm I.D.)
Eluent : A :0.1% Formic acid; B :0.1% Formic acid in AcCN;
Gradient : 45%B-95%B over 29min.
Flow rate : 1.00mL/min
Column temp. : 25℃
Detection : UV238nm
Sample : Pravastatin sodium, Mevastatin and Simvastatin, 1mg/ml each;.
Injection : 5μL



Pravastatin sodium



(+)-Compactin; Mevastatin



(+)-Simvastatin, Simvastatin

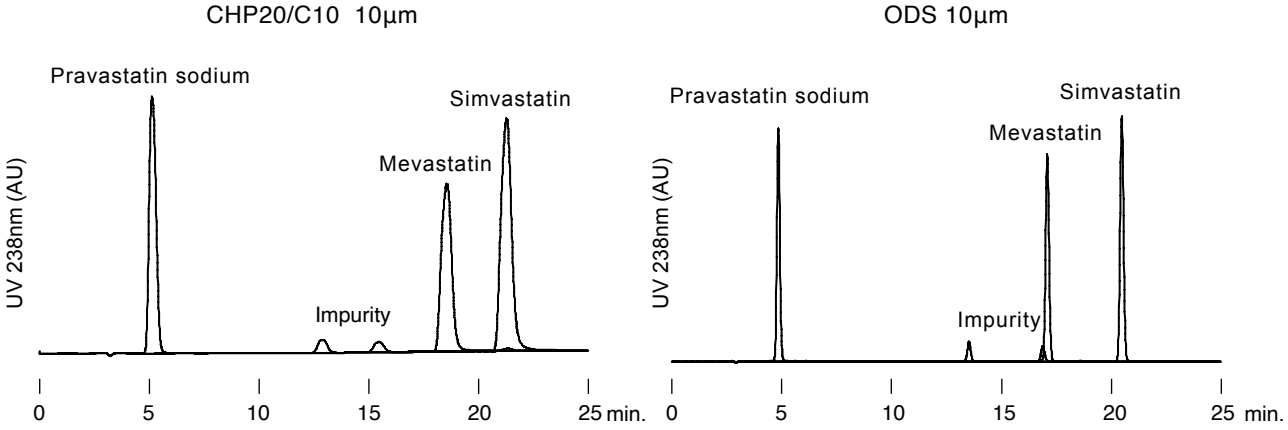
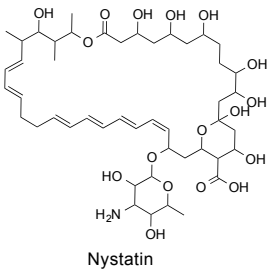
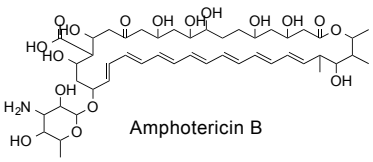


Fig. 5-17 Polyene antibiotics

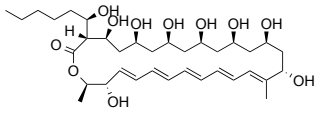
Conditions
Column : MCI GEL™ CHP20/C10 (10μm 250 ×4.6mm I.D.) and ODS (10μm 250 ×4.6mm I.D.)
Eluent : A :0.1% Formic acid; B :0.1% Formic acid in AcCN; A/B=60/40;
Flow rate : 1.00mL/min
Column temp. : 25℃
Detection : UV305nm for Nystatin, VIS405nm for Amphotericin B and UV340nm for Filipin;
Sample : Pravastatin sodium, Mevastatin and Simvastatin, 1mg/ml each;.
Injection : 10μL



Nystatin



Amphotericin B



Filipin

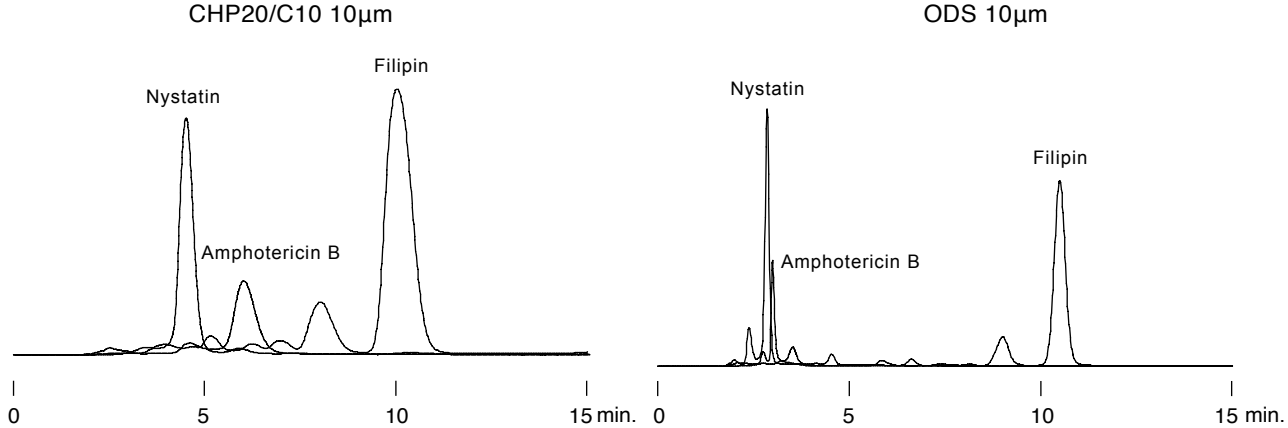


Fig. 5-18 Proteins

Conditions
Column : MCI GEL™ CMG20/C10
4.6mm I.D.×250mm
Eluent : A 0.05% TFA/CH_3CN=80/20
B 0.05% TFA/CH_3CN=30/70
A → B 45min linear gradient
Flow rate : 0.5mL/min
Column temp. : 25°C
Detection : 280nm
Sample : 1. Ribonuclease A
2. Cytochrome C
3. Transferrin
4. α-Chymotrypshinogen A
5. β-Lactoglobulin

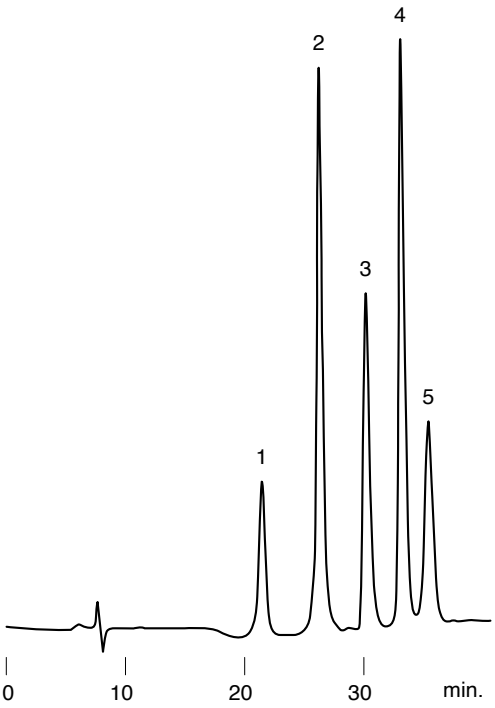
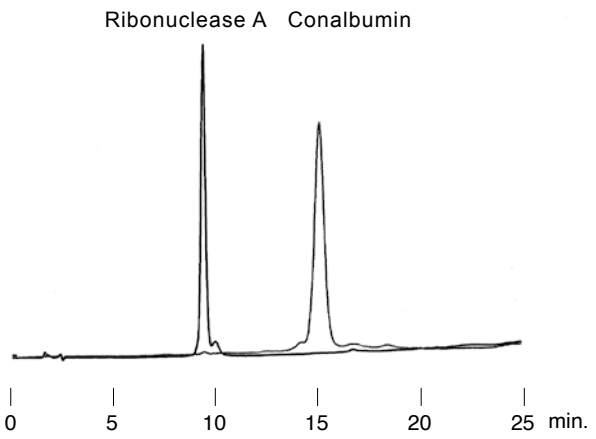
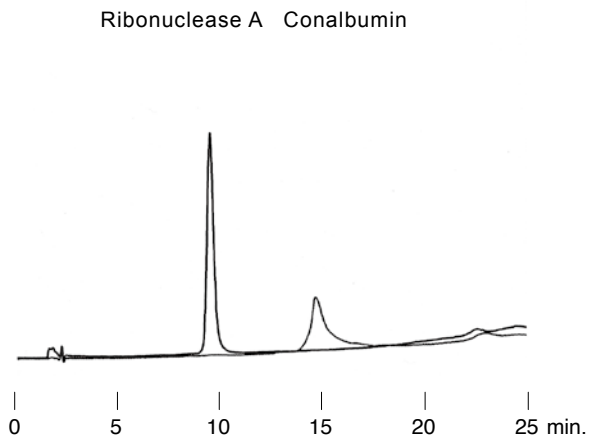


Fig. 5-19 Proteins

CHP20/C10 10μm



ODS 10μm



Conditions
Column : 150 ×4.6mm I.D.
Eluent : A :0.1% TFA;
B :0.1% TFA in AcCN
Flow rate : 1.00mL/min
Column temp. : 20%B-60%B over 20min;
Detection : UV280nm;
Sample : Ribonuclease A and Conalbumin 2mg/ml;.
Injection : 10μL

Application data of CHP series

Fig. 5-20 Insulin

Conditions
Column : MCI GEL™ CHP20/C10
MCI GEL™ CMG20/C10
ODS 10μm
4.6mm I.D.×150mm
Eluent : A) 0.1%TFA, H_2O
B) 0.1%TFA, CH_3OH
Gradient : 20%B→60%B over 20min.
Flow rate : 1.0mL/min
Column temp. : 40°C
Detection : 280nm
Sample : Insulin Glargine and human recombinant , 1mg/mL each
Injection : 10μL

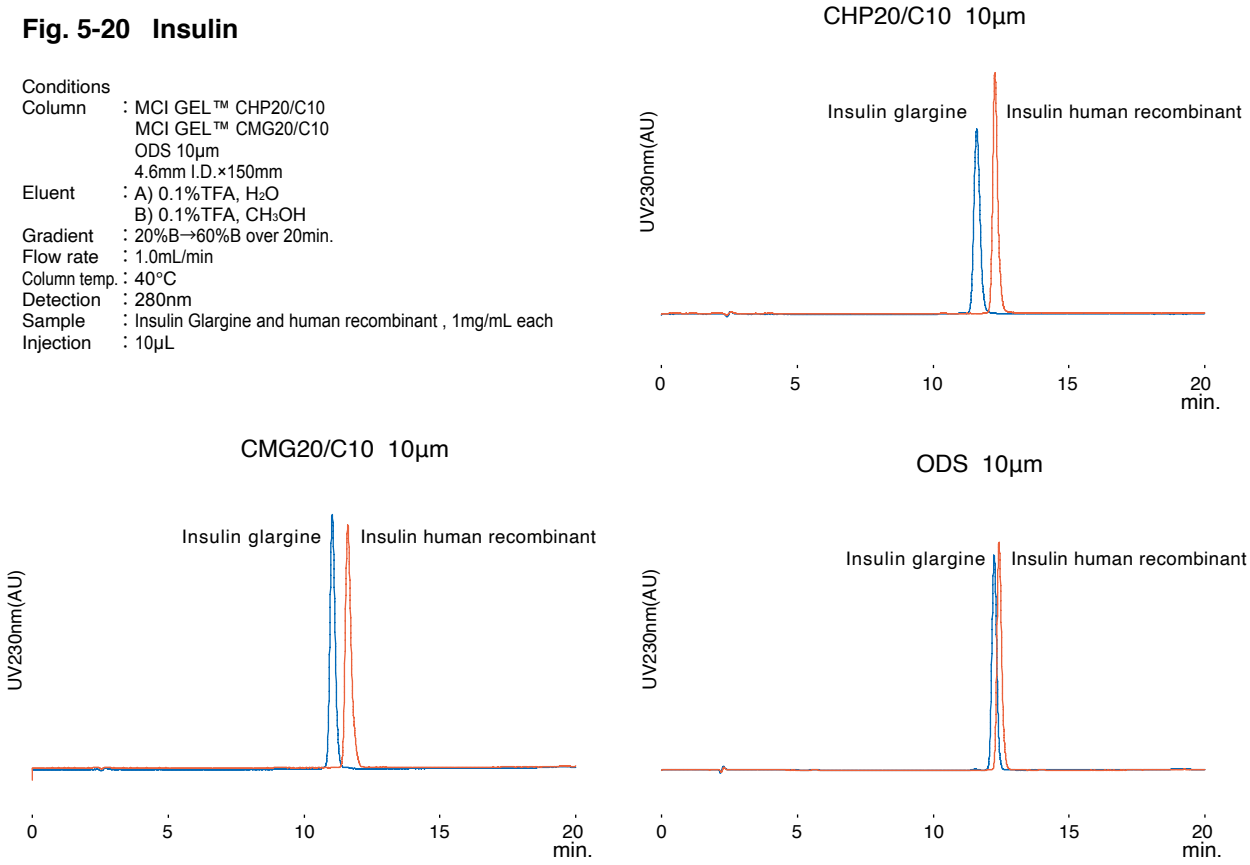
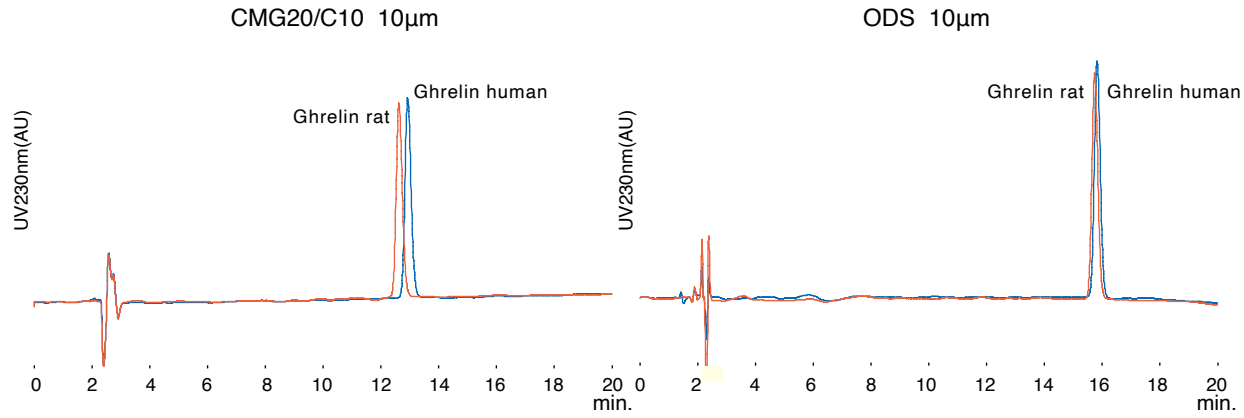


Fig. 5-21 Ghrelin

Conditions
Column : MCI GEL™ CMG20/C10
ODS 10μm
4.6mm I.D.×150mm
Eluent : A) 0.1%TFA, H_2O
B) 0.1%TFA, AcCN
Gradient : 10%B→60%B over 25min.
Flow rate : 1.0mL/min
Column temp. : 40°C
Detection : 230nm
Sample : Ghrelin rat and Ghrelin human ,0.1mmol/l each
Injection : 10μL

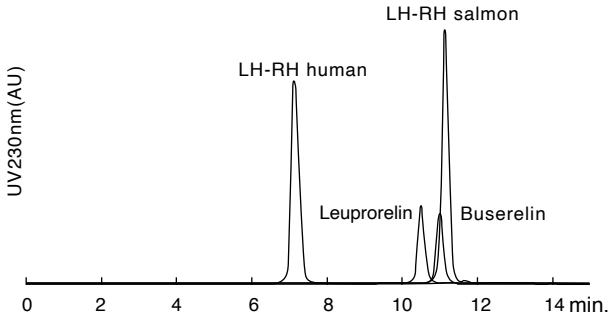


Application data of CHP series

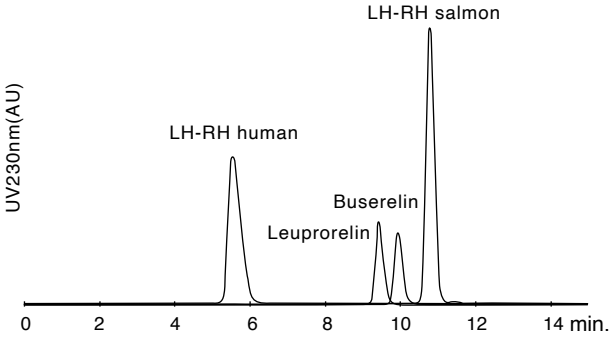
Fig. 5-22 Leuprorelin

Conditions
Column : MCI GEL™ CHP20/C10
MCI GEL™ CMG20/C10
ODS 10μm
4.6mm I.D.×150mm
Eluent : A) 0.1%TFA, H_2O
B) 0.1%TFA, AcCN
Gradient : 20%B→60%B over 20min.
Flow rate : 1.0mL/min
Column temp. : 40°C
Detection : 280nm
Sample : Leuprorelin,LHRH human, LHRH salmon and Buserelin ,1mg/mL each
Injection : 10μL

CHP20/C10 10μm



CMG20/C10 10μm



ODS 10μm

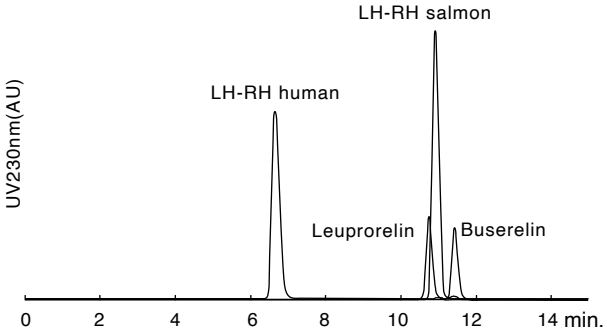
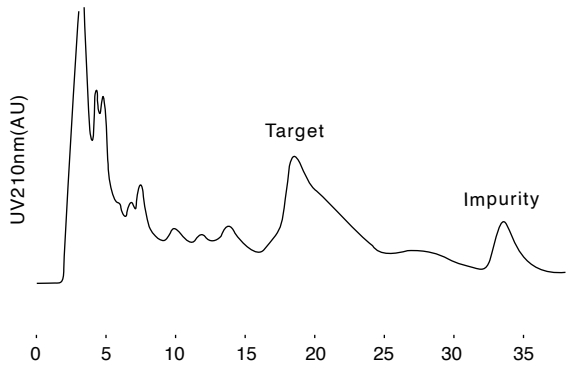


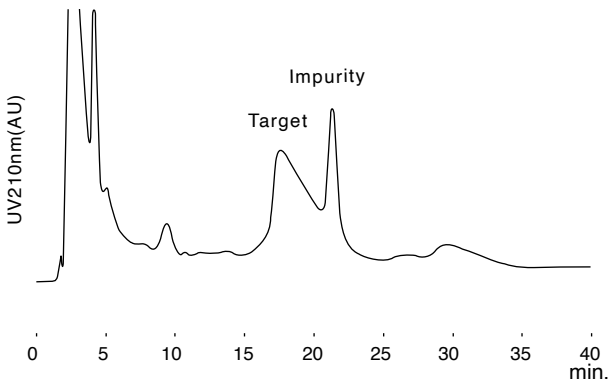
Fig. 5-23 Sifuvirtide

Conditions
Column : MCI GEL™ CMG20/C10
ODS 10μm
4.6mm I.D.×150mm
Eluent : 0.1%TFA,/CH3CN=68/32
Flow rate : 1.0mL/min
Column temp. : 40°C
Detection : 210nm
Sample : Sifuvirtide crude(purity 35.5%) 2.1mg/mL
Injection : 0.4mL

CMG20/C10 10μm



ODS 10μm



Application data of CHP series

Fig. 5-24 ssRNA Ladder Marker

Conditions
Column : MCI GEL™ CMG20/C10
ODS 10μm
4.6mm I.D.×150mm
Eluent : A)100mM TEAA, H_2O
B)100mM TEAA, CH_3CN
Gradient : CHP10/C10 10%B→40%B over 30min
ODS 10μm 8%B→40%B over 30min
Flow rate : 1.0mL/min
Column temp. : 40°C
Detection : 260nm
Sample : 14-30 ssRNA Ladder Marker [max.0.04mg/mL]
Injection : 5μL

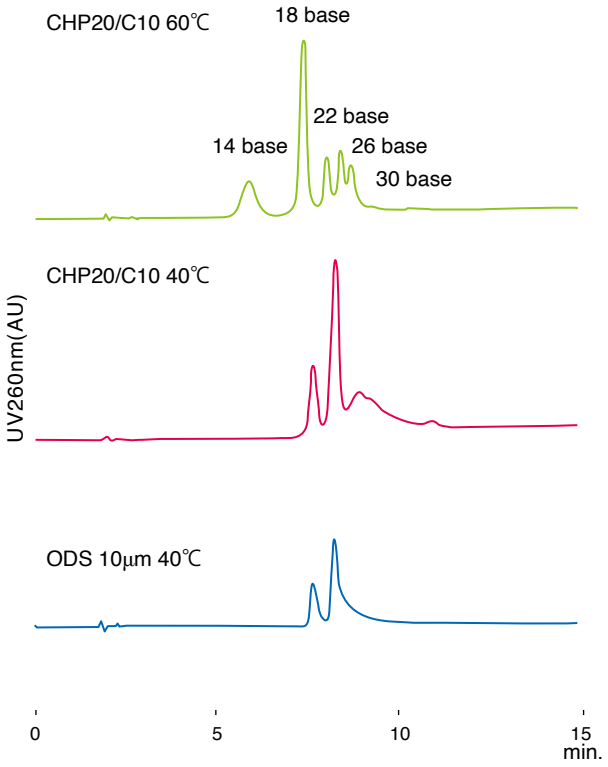
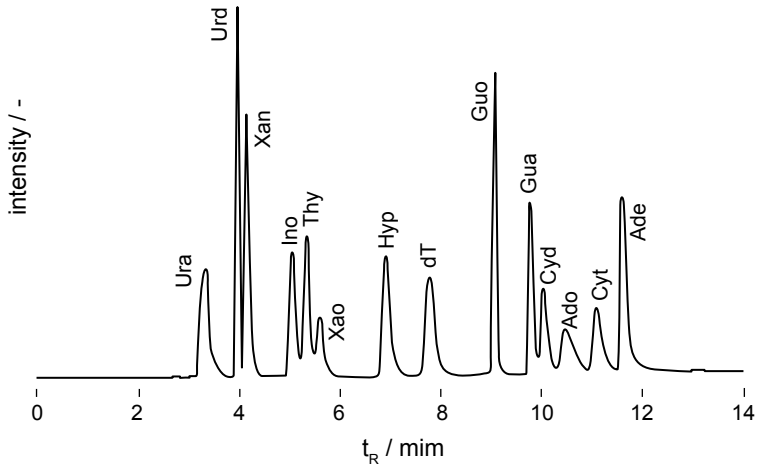


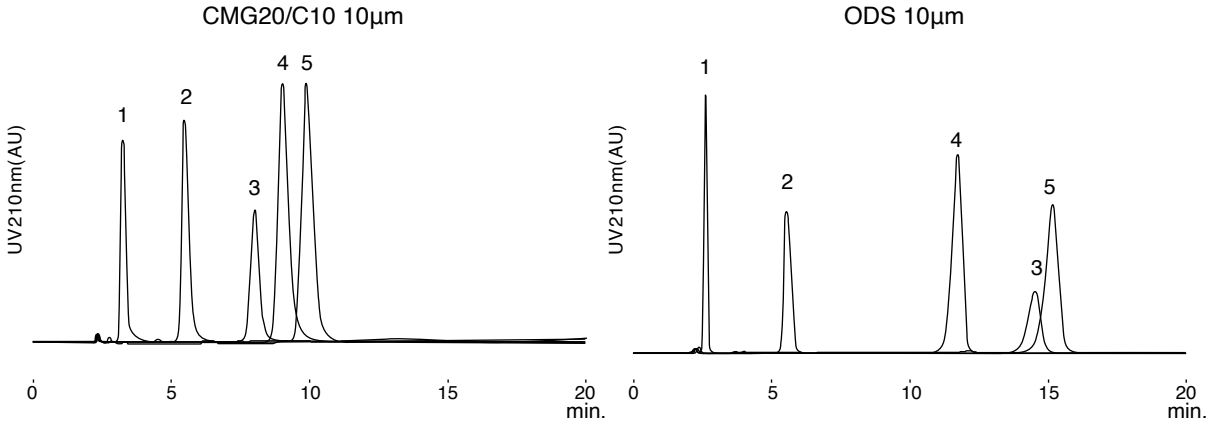
Fig. 5-25 Nucleotide

Conditions
Column : MCI GEL™ CHK40/C04
4.6mm I.D.×150mm
Eluent : A)19 mM H_3PO_4 / 1 mM NaH_2PO_4 / 5.0% ACN
B)20 mM Na_2HPO_4 / 100 mM $NaClO_4$ / 30% ACN
Gradient : 0-4.0min 0%B 4.0-5.0min 0→30%B 5.0min-6.0min 30%B 6.0min-7.0min 30→50%B
7.0min-10.0min 50→65%B 10.0min-11.0min 65%B 11.0min- 0%B
Flow rate : 0.8mL/min
Column temp. : 50℃
Detection : UV260nm
Sample : 1.Ura, 2.Xan, 3.Thy, 4.Hyp, 5.Gua, 6.Cyt, 7.Ade, 8.Urd, 9.Xao, 10.dT, 11.Ino, 12.Guo, 13.Cyd, 14.Ado
Injection : 20μL



(Data provided by Professor Yokoyama of Yokohama National University)

Fig. 5-26 Linalool



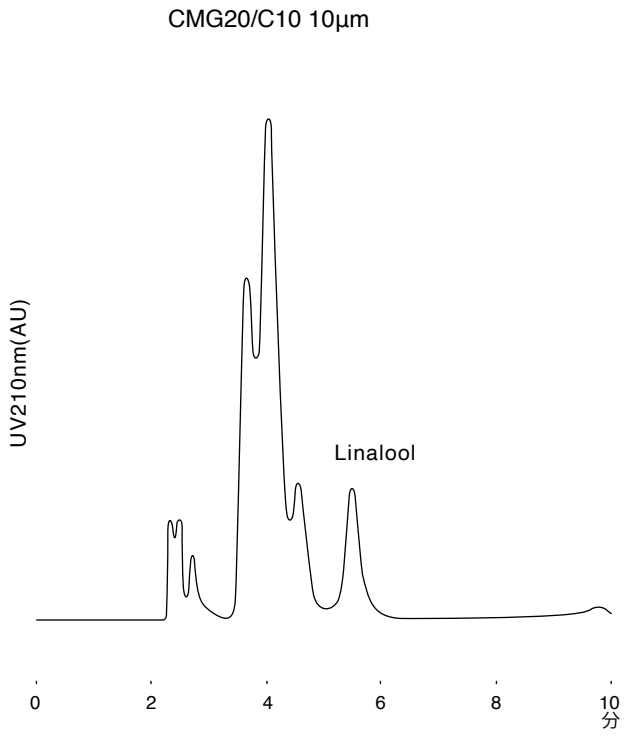
Conditions

Column	:	MCI GEL™ CMG20/C10 ODS 10µm 4.6mm I.D.×150mm
Eluent	:	Hexan/Ethanol=99.5/0.5
Flow rate	:	1.0mL/min
Column temp.	:	40°C
Detection	:	210nm
Sample	:	1:Linalyl Acrtate 1mg/mL 2:Linalool 1mg/mL 3:β-Citronellool 1mg/mL 4:Nerol 0.5mg/mL 5:Geraniol 0.5mg/mL
Injection	:	10µL

Fig. 5-27 Coriander

Conditions

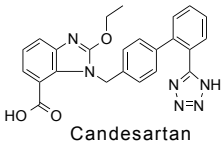
Column	:	MCI GEL™ CMG20/C10 4.6mm I.D.×150mm
Eluent	:	Hexan/Ethanol=99.5/0.5
Flow rate	:	1.0mL/min
Column temp.	:	40°C
Detection	:	210nm
Sample	:	Coriander
Injection	:	10µL

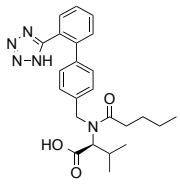


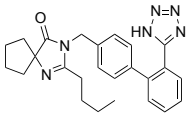
Application data of CHP series

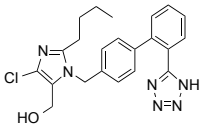
Fig. 5-28 Application data of CHK40/C04：Sepatation of Sartans

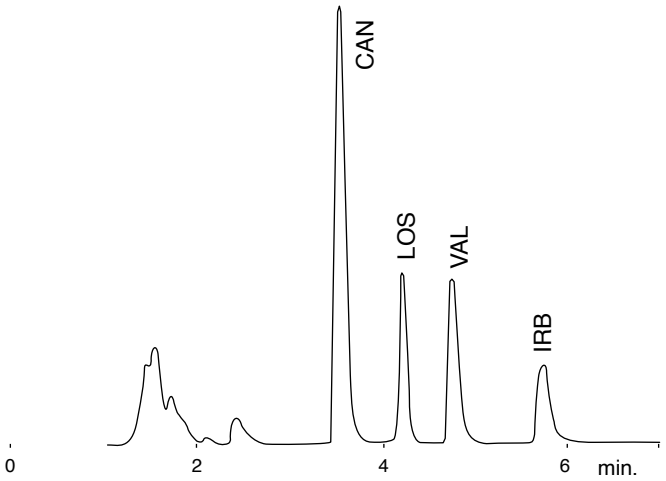
Conditions
Column ：MCI GEL™ CHK40/C04
4.6mm I.D.×150mm
Eluent ：A) 10 mM NaH_2PO_4 +0.2 mM Na_2HPO_4 (25%ACN)
B) 10 mM NaH_2PO_4 +1.0 mM Na_2HPO_4 (40%ACN)
Gradient ：0.5min 0%B 0.5-2.0min 50%B
2.0min-- 90%B
Flow rate ：1.0mL/min
Column temp. ：50°C
Detection ：UV
Sample ：Candesartan(CAN),Losartan(LOS),
Valsartan(VAL), Irbesartan(IRB)
Injection ：20μL


Candesartan


Valsartan


Irbesartan


Losartan



(Data provided by Professor Yokoyama of Yokohama National University)

(Polyphenon 60)

Fig. 5-29 Modified Styrene Divinylbenzene CHP07/C04

Conditions
Column ：MCI GEL™ CHP07/C04
4.6mm I.D.×150mm
Eluent ：CH_3OH/10mM-Acetic acid＝60/40
Flow rate ：0.46mL/min
Column temp. ：60°C
Detection ：280nm
Sample ：Polyphenon 60(10mg/mL) each 10μL

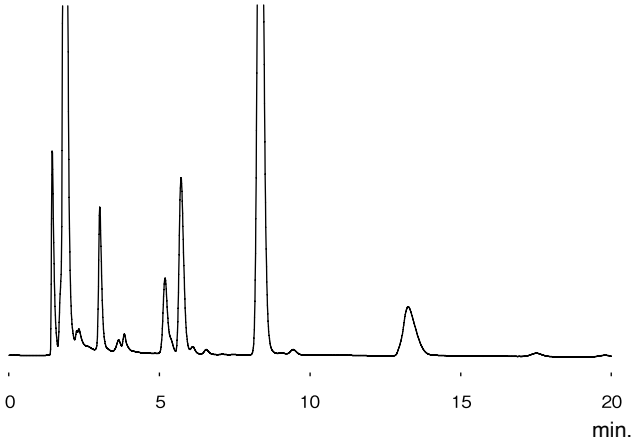
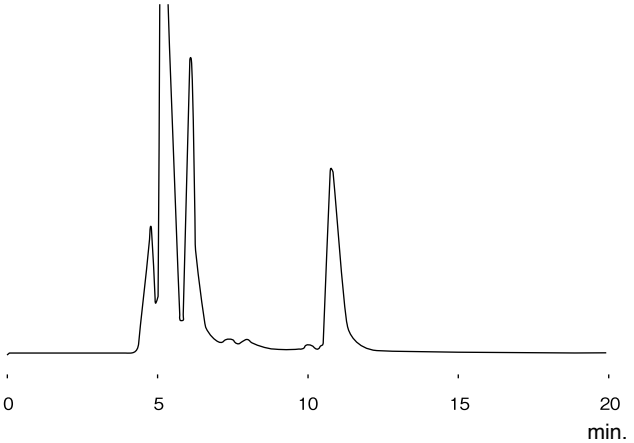


Fig. 5-30 Styrene Divinylbenzene CHP20/C04

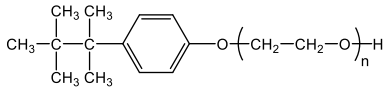
Conditions
Column ：MCI GEL™ CHP20/C04
4.6mm I.D.×150mm
Eluent ：CH_3OH/10mM-Acetic acid＝60/40
Flow rate ：0.46mL/min
Column temp. ：60°C
Detection ：280nm
Sample ：Polyphenon 60(10mg/mL) each 10μL



(TritonX-100)

Fig. 5-31 C18-alkylated aliphatics CHPOD/C04

Conditions
Column : MCI GEL™ CHPOD/C04
4.6mm I.D.×150mm
Eluent : 50vol%CH_3CN
Flow rate : 0.50mL/min
Column temp.: 40°C
Detection : 254nm
Sample : Triton X-100
(Polyoxyethylene octyl phenyl ether)
1% each 10μL



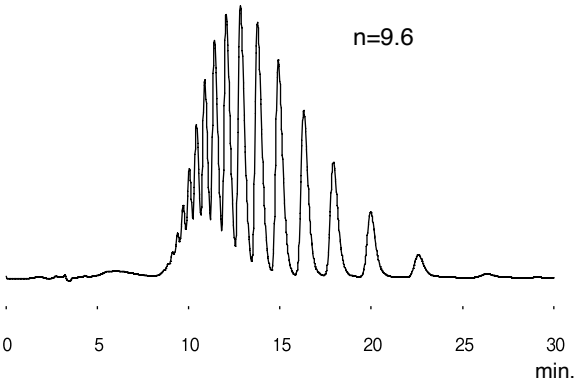
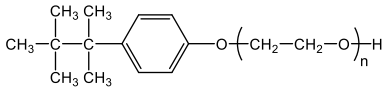


Fig. 5-32 ODS (5μm)

Conditions
Column : ODS (5μm)
4.6mm I.D.×250mm
Eluent : 50vol%CH_3CN
Flow rate : 1.00mL/min
Column temp.: 40°C
Detection : 254nm
Sample : Triton X-100
(Polyoxyethylene octyl phenyl ether)
1% each 10μL



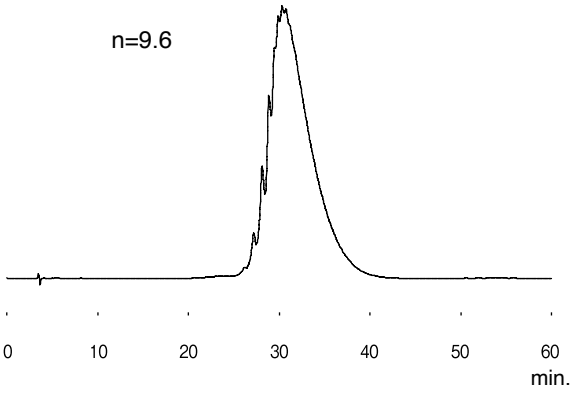
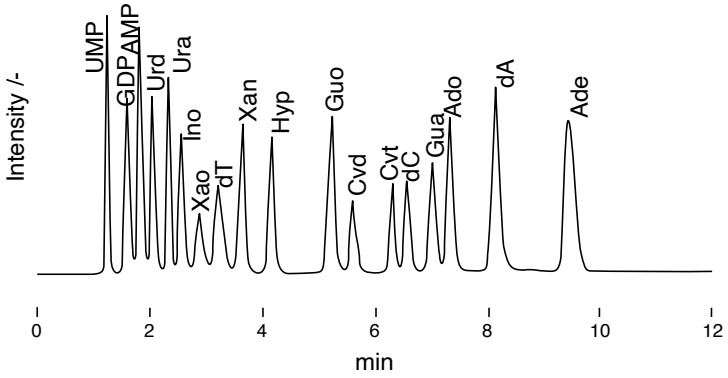
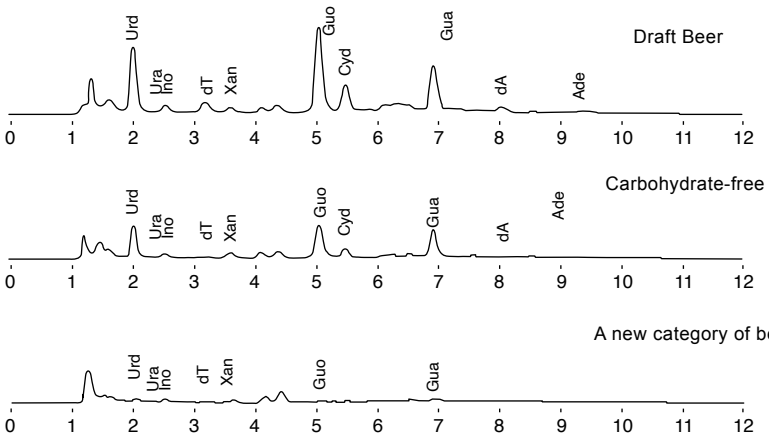


Fig. 5-33 Application data of Nucleic base/Nucleoside and Beer

Conditions
Column : MCI GEL™ CHK45/C05
4.6mm I.D.×150mm
Eluent : A) 8 mM H_3PO_4
B) 10 mM H_3PO_4 /30% ACN
Gradient 0-0.7min 0%B 0.7-3.0min 0→40%B 3.0--3.2min 40%B
3.2--3.5min 40→80%B 3.5--8.0min 80%B 8.0min-- 0%B
Flow rate : 1.3mL/min
Column temp.: 45°C
Detection : UV260nm
Injection : 20μL



Analysis of various category beer



(Data provided by Professor Yokoyama of Yokohama National University)