CYCLODEXTRIN NEWS
VOLUME 31. No. 01. JANUARY 2017 ISSN 0951-256X

Potential of Cyclodextrins in Quorum Sensing

Many bacteria regulate their cooperative activities through releasing, sensing and responding to small signaling molecules. This mechanism called quorum sensing (QS) makes possible for a population of bacteria to behave as a multi-cellular organism in host colonization, formation of biofilms, defense against competitors and adaptation to changing environment (Davie and O’Toole 2000; Waters and Bassler 2001). In infectious diseases the invading bacteria need to reach a critical cell density before they express virulence. Biofilm infections including infections of bone, airway/lung tissue, cardiac tissues, middle ear, gastrointestinal tract, eye, urogenital tract, prosthetic devices, indwelling catheters, implants and dental diseases often resist to the highest dose of antibiotics, because the bacteria present in biofilms have characteristics different from those of the free-living counterparts, including increased resistance to antibiotics (Li and Tian 2012).

QS is one of the cell-cell communication mechanisms on cell population density. Gram-negative bacteria produce several kinds of N-acyl-L-homoserine lactones (AHLs) as signal compounds, while Gram-positive bacteria produce signal peptides called autoinducing peptides (AIPs). There is a third mechanism applying autoinducers (AI-2, a furasonyl borate diester) both by Gram-negative and Gram-positive bacteria. Any compound that prevents production of signal molecules or interactions between signal molecules and related receptor proteins might block bacterial quorum sensing and its gene expression. So, quorum sensing is a new target for the development of antiobiotic agents.

Quorum sensing was discovered in the early 1970s studying the bioluminescence of Gram-negative bacterium *Vibrio fischeri* (Figure 1). Once the bacterial population has reached a specific size, only then does light production commence. It turned out that this bacterium has a sensing system to monitor its population density. This was the start of sociomicrobiology. In *Vibrio fischeri* AHL binds to the protein product of the LuxR gene and activates it. The activated LuxR activates several other genes playing role in the synthesis of AHL. Thus, AHL acts as an autoinducer. Other genes responsible for a protein known as a luciferase and further proteins involved in the synthesis of the luciferase's substrate, tetradecanal are also affected.

Figure 1. Microscopic photo on Vibrio fisheri, Pseudomonas aeruginosa, Serratia marcensens, Chromobacterium violaceum

The mechanism seems to be general regulating not only bioluminescence but also virulence of pathogenic bacteria, biofilm development, both key factors in determining the success of infection.

Each Gram-negative bacteria species produces a unique AHL or a unique combination of AHL and, as a result, only the members of the same species recognize and respond to their own signal molecule. AHLs produced by different bacteria differ in the length of the R-group side-chain. Chain lengths vary from 4 to 18 carbon atoms and in the substitution of a carbonyl at the third carbon (Figure 2) (Ikeda et al. 2003). AHLs freely diffuse across the cell membrane and increase in concentration in proportion to cell density. A related LuxR-like protein is responsible for recognition of the AHL and when bound to the AHL, LuxR-like protein binds to specific promoter DNA elements and activates transcription of target genes (Parsek et al. 1999).

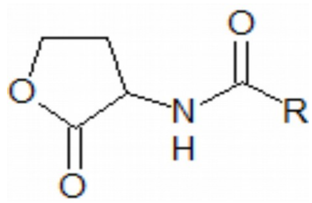

Figure 2. Structure of N-acyl-L-homoserine lactones

Most of signaling peptides produced by Gram-positive bacteria typically consist of 5–25 amino acids and some contain unusual side chains (Claverys et al. 2006). For instance, *Streptococcus mutans* (persistent in dental plaque) produces a 21-amino acid signal peptide (CSP). When CSP reaches the critical concentration it activates target genes encoding bacteriocins and bacteriocin self-immunity proteins to kill other species in the biofilm. Recently, a new quorum sensing system with a double-tryptophan peptide pheromone as signal molecule has been also identified in *S. mutans* (Mashburn-Warren et al. 2010).

Complexation of signal molecules (AHLs or peptides) by CDs opens the way for the development of CD-based signal traps – a still unexplored strategy for fighting against bacterial infections via suppressing quorum sense, the communication between bacterial cells. This concept does not aim to kill the bacteria but to decrease their virulence (Hirakawa and Tomita 2013).

ACD and BCD form inclusion complex with C4 (R = propyl) encapsulating the acyl side chain (Figure 3) (Ikeda et al. 2003). The association constants calculated from NMR data are 18.8 and 23.8 M^{-1}, respectively. Similarly, the acyl chain of (S)-N-(3-oxo-octanoyl)-HSL is included in the cavity of BCD and hydrogen bonding between the 3-keto moiety and the C-6 OH of BCD was found by NMR (Cabeca et al. 2011). The association constant of both C6-HSL and 3-oxo-C6-HSL was about 700 M^{-1} (Okano et al. 2012). As the hydrophobic acyl chain is the most important interacting site for the signal molecule and the cell membrane, the inclusion of the acyl chain into the cavity will hinder the interaction with the cell membrane.

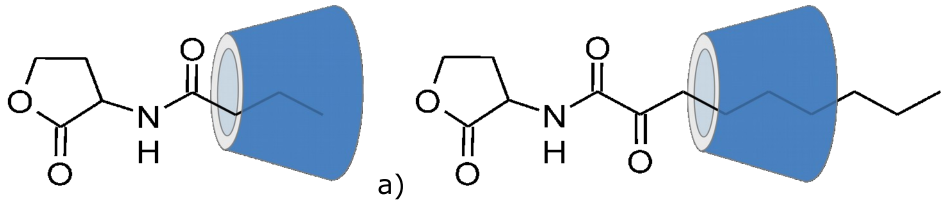

Figure 3. Scheme of CD complex with C4-HSL (R=propyl) (a) and C8-OHSL (R=octanoyl) (b) N-acyl-L-homoserine

Adding various CDs to the culture medium, the free AHLs concentration is decreased by complexation and with this the autoinducing activity in *Pseudomonas aeruginosa* (Figure 1) culture is also reduced. ACD, BCD and its methylated derivatives decrease autoinducing activities due to complex formation with AHLs. The cavity of GCD seems to be too large for complex formation.

Table 1. β-galactosidase activity as autoinducing activity (expressed in percentage relative to the control) (Ikeda et al. 2003)

Control	ACD	BCD	Dimeb	Trimeb	GCD	Glucose
100	21	26	31	29	98	99

Another method for characterizing quorum sensing is the measurement of intracellular pigments, such as pyocyanin (blue) and prodigiosin (red) (Figure 4) in cultures of *P. aeruginosa* and *Serratia marcensens* (Figure 1), respectively (Kato et al. 2005 and 2007). The expression of these pigments is controlled by AHL-mediated QS. HPBCD in solution inhibits prodigiosin production of *S. marcensens* in a concentration-dependent manner (Okata et al. 2012). Applying poly(acrylic acid) gel sheets together with HPBCD the relative prodigiosin concentration decreased to 10% of the control since both the gel and HPBCD bound AHLs and this way inhibited QS. HPBCD immobilized in the gel behaves as a trap of cell-to-cell communication signal (Kato et al. 2005a). BCD immobilized on microspheres with poly(methacrylic acid) shell layer on polystyrene cores captured AHL of *S. marcensens* and reduced QS suppressing prodigiosin production to 30%. The expression of QS-dependent genes was also inhibited (Okano et al. 2016).

Applying HPBCD with carboxymethylcellulose gels in *S. marcensens* culture, the relative prodigiosin production decreased to 56% of the control (with cellulose gel and with 10 mM HPBCD only 95% and 86%) (Kato et al. 2006). This result suggested that the ionic interaction between acceptor molecules and the AHLs could stabilize the inclusion complex and then block the sequential QS-regulated process. The cellulose ether hydrogel with HPBCD reduced the expression of the QS-controlled genes, the production of pyocyanin and galactosidase via complexing AHLs (Kato et al. 2007). Even better results were obtained with cellulose gel sheets containing ACD and prepared by temperature induced phase separation: the AHL-mediated prodigiosin production decreased to 10% of the control (Kato et al. 2009).

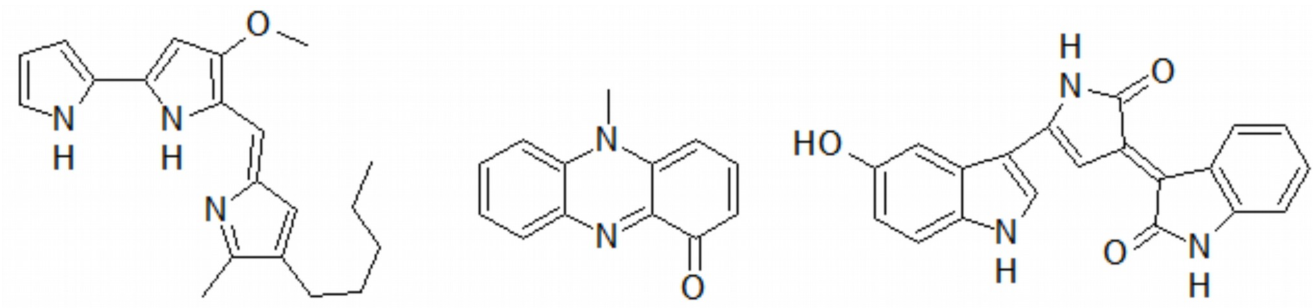

Figure 4. Chemical structure of prodigiosin, pyocyanin and violacein, secondary metabolites of Serratia marcensens, Pseudomonas aeruginosa and Chromobacterium violaceum, respectively (All of them are good candidates for complex formation with cyclodextrins. For instance, CD stimulated the fermentation of prodigiosin by S. marcensens (Bar and Rokem 1990); the antitumor and antiulcer effects of violacein/BCD complex were studied by De Azevedo et al. 2000 and 2003)

The marine photosynthetic bacterium *Rhodovulum sulfidophilum* produces extracellular nucleic acids involved in its flocculation. ACD as an inhibitor of QS inhibited the floc formation and increased the extracellular DNA production (Suzuki et al. 2009).

The alkylamino-BCD derivatives form complexes of high stability with AHLs. The association constants increase with increasing chain length of the alkylamino moiety >C7 (Table 2) (Morohoshi et al. 2013).

Table 2. Association constants between N-hexanoyl-L-homoserine lactone, C6-HSL (R=hexanoyl) and alkylamino-BCD derivatives (determined by phenolphthalein competition) and their inhibition of autoinducer effects on *Serratia marcensens* (Morohoshi et al. 2013)

	Association constant (M^{-1})	Relative prodigiosin production (%)
BCD	390 ± 5	49 ± 8
6-Butylamino-BCD	92± 32	81 ± 8
6-Pentylamino-BCD	121 ± 11	74 ± 1
6-Hexylamino-BCD	172 ± 9	60 ±2
6-Heptylamino-BCD	520 ± 120	18 ± 2
6-Octylamino-BCD	730 ± 94	16 ± 2
6-Dodecylamino-BCD	2900 ± 640	1 ± 1
6,6'-Dioctylamino-BCD	2670 ± 370	3 ± 2

The improved inhibitory effect of alkylamino-CDs (at 10 mg/mL concentration) was demonstrated on other bacteria as well. The 6-alkylamino BCD derivatives effectively inhibited AHL-mediated QS in *Chromobacterium violaceum* (Figure 1) and *P. aeruginosa* (PAO1) (Morohoshi et al. 2013). *C. violaceum* produces violacein (Figure 4) in response to the presence of C6-HSL. Native BCD inhibited the violacein production by about 40%, while the

6-dodecylamino-BCD caused 99% inhibition. *P. aeruginosa* produces N-(3-oxododecanoyl)-L-homoserine lactone (C12-HSL) and regulates the production of elastase enzyme as a virulence-enhancing factor. Native BCD did not show inhibitory activity on elastase production, 6-dodecylamino-BCD and 6,6'-dioctylamino-BCD caused about 70% and 90% inhibition of elastase activity (Morohoshi et al. 2013).

Based on NMR studies it was concluded that both the hydrophobic chain of AHLs and the alkyl chain on the BCD are simultaneously included into the CD cavity.

Understanding bacterial social behaviors and their molecular mechanisms in the development of biofilms will greatly facilitate the development of novel strategies in the prevention and treatment of biofilm infections. As inclusion complex formation of AHL with CDs keeps the concentration of AHL below the activation threshold new CD-based weapons to control bacterial growth might be developed.

References

Bar, R., Rokem, J.S. (1990) Cyclodextrin-stimulated fermentation of prodigiosin by Serratia marcescens. Biotechnol. Lett. 12(6), 447-8

Cabeca, L.F., Pomini, A.M., Cruz, P.L.R., Marsaioli, A.J. (2011) Binding events of (S)-N-(3-Oxo-octanoyl)-homoserine lactone with *Agrobacterium tumefaciens* mutant cells studied by saturation transfer difference NMR. J. Braz. Chem. Soc. 22(4), 702-708

Claverys, J.P., Prudhomme, M., Martin, B. (2006) Induction of competence regulons as a general response to stress in Gram-positive bacteria. Ann. Rev. Microbiol. 60, 451–475

Davey M.E., O'Toole G.A. (2000) Microbial biofilms: from ecology to molecular genetics. Microbiol. Mol. Biol. Rev. 64, 847–867

De Azevedo, M.B.M., Alderete, J., Rodriguez, J.A., Souza, A.O., Rettori, D., Torsoni, M.A., Faljoni-Alario, A., Haun, M., Duran, N. (2000) Biological activities of violacein, a new antitumor indole derivative, in an inclusion complex with b-cyclodextrin. J. Inclusion Phenom. Macrocyclic Chem. 37(1-4), 93-101

Duran, N., Justo, G.Z., Melo, P.S., De Azevedo, M.B.M., Brito, A.R.M.S., Almeida, A.B.A., Haun, M. (2003) Evaluation of the antiulcerogenic activity of violacein and its modulation by the inclusion complexation with beta-cyclodextrin. Can J. Physiol. Pharmacol. 81(4), 387-396

Hirakawa, H., Tomita, H. (2013) Interference of bacterial cell-to-cell communication: a new concept of antimicrobial chemotherapy breaks antibiotic resistance. Front. Microbiol., 4, 114

Ikeda, T., Inoue, Y., Suehiro, A., Ikeshoji, H., Ishida, T., Takiguchi, N., Kuroda, A., Kato, J., Ohtake, H. (2002) The effects of cyclodextrins on autoinducer activities of quorum sensing in Pseudomonas aeruginosa. J. Inclusion Phenom. Macrocyclic Chem. 44(1-4), 381-382

Kato, N., Matsumoto, H., Nozawa, T., Morohoshi, T., Ikeda, T. (2005a) Uptake of signal molecules for Gram-negative bacterial cell-cell communication on polymer gels. Trans. Mater. Res. Soc. Japan, 30(3), 815- 818 and 827- 830

Kato, N., Morohoshi, T., Matsumoto, H., Tanaka, T., Ikeda, T. (2005) Regulation of quorum sensing in Serratia marcescens by adsorption of N-acylhomoserine lactones on cyclodextrin immobilized gel. Trans. Mater. Res. Soc. Japan 30(3), 815- 818

Kato, N., Morohoshi, T., Nozawa, T., Matsumoto, H., Ikeda, T. (2006) Control of Gram-Negative Bacterial Quorum Sensing with Cyclodextrin Immobilized Cellulose Ether Gel J. Inclusion Phenom. Macrocyclic Chem. 56(1-2), 55-59

Kato, N., Tanaka, T., Nakagawa, S., Morohoshi, T., Hiratani, H., Ikeda, T. (2007) Control of virulence factor expression in opportunistic pathogens using cyclodextrin immobilized gel. J. Inclusion Phenom. Macrocyclic Chem. 57(1-4), 419-423

Kato, N., Kobayashi, A., Motohashi, H., Ozonoe, Y., Morohoshi, T., Ikeda, T. (2009) Development of a novel hydrogel to prevent bacterial infectious diseases. Prog. Colloid Polym. Sci. 136, 155-162

Li, Y.H., Tian, X. (2012) Quorum sensing and bacterial social interactions in biofilms. Sensors (Basel) 12(3), 2519–2538

Miller M.B., Bassler B.L. (2001) Quorum sensing in bacteria. Annu. Rev. Microbiol. 55, 165–199

Morohoshi, T., Tokita, K., Ito, S., Saito, Y., Maeda, S., Kato, N., Ikeda, T. (2013) Inhibition of quorum sensing in Gram-negative bacteria by alkylamine-modified cyclodextrins. J. Biosci. Bioeng. 116, 175–179

Okano, C., Arai, M., Nasuno, E., Iimura, K.I., Morohoshi, T., Ikeda, T., Kato, N. (2012) Beta-cyclodextrin interaction with N-hexanoyl homoserine lactone as quorum sensing signal produced in Gram-negative bacteria. Trans. Mater. Res. Soc. Japan 37(2), 315-318

Okano, C., Nasuno, E., Iimura, K.I., Kato, N. (2016) Cyclodextrin-immobilized microspheres for uptake of the quorum-sensing signaling molecule N-acylhomoserine lactone. Appl. Polym. Sci. 133, 43198

Parsek M.R., Val D.L., Hanzelka B.L., Cronan J.E., Jr., Greenberg E.P. (1999) Acyl homoserine-lactone quorum-sensing signal generation. Proc. Natl. Acad. Sci. USA. 96, 4360–4365

Suzuki, H., Daimon, M., Awano, T., Umekage, S., Tanaka, T., Kikuchi, Y. (2009) Characterization of extracellular DNA production and flocculation of the marine photosynthetic bacterium Rhodovulum sulfidophilum. Appl. Microbiol. Biotechnol. 84(2), 349-356

Éva fenyvesi

CycloLab Cyclodextrin R&D Laboratory, Ltd.,

Budapest, HUNGARY

BIBLIOGRAPHY & KEYWORDS

1. CDs: Derivatives, Production, Enzymes, Toxicity

Duchêne, D.; Bochot, A.

Thirty years with cyclodextrins

Beads, Inclusions, Nanoparticles, Self-assembling systems

International Journal of Pharmaceutics, 2016, 514, 58-72; DOI:10.1016/j.ijpharm.2016.07.030

Huang, M.; Ren, J.; Li, C.; Gu, Z.; Hong, Y.; Cheng, L.; Li, Z.

Double mutations enhance β-cyclization activity of cyclodextrin glycosyltransferase from *Bacillus circulans*

Industrial production of β-cyclodextrin

Journal of Molecular Catalysis B: Enzymatic, 2016, *In Press*; DOI:10.1016/j.molcatb.2016.12.002

Singireddy, A.; Pedireddi, S. R.; Nimmagadda, S.; Subramanian, S.

Beneficial effects of microwave assisted heating versus conventional heating in synthesis of cyclodextrin based nanosponges

Crystallinity, Polydispersity index

Materials Today: Proceedings, 2016, 3, 3951-3959; DOI:10.1016/j.matpr.2016.11.055

Vaňková, N.; Česla, P.

Prediction of gradient retention data for hydrophilic interaction liquid chromatographic separation of native and fluorescently labeled oligosaccharides

Mixed-mode retention and oligomeric mixed-mode model, Maltooligosaccharides, 2-Aminobenzoic acid, 8-Aminonaphthalene-1,3,6-trisulfonic acid

Journal of Chromatography A, 2017, 1485, 82-89; DOI:10.1016/j.chroma.2017.01.032

2. CD complexes: Preparation, Properties in solution and in solid phase, Specific guest

Aiello, F.; Uccello-Barretta, G.; Falugiani, N.; Nardelli, F.; Balzano, F.

Cyclodextrins as inhibitors of the precipitation of riboflavin-5'-phosphate due to presence of zinc chloride: A NMR investigation

Nuclear magnetic resonance, Complexation phenomena, Solubility, β-CD, Solubilizing power

Journal of Pharmaceutical and Biomedical Analysis, 2016, *In Press*; DOI:10.1016/j.jpba.2016.12.039

Baul, T. S. B.; Kehie, P.; Duthie, A.; Guchhait, N.; Raviprakash, N.; Mokhamatam, R. B.; Manna, S. K.; Armata, N.; Scopelliti, M.; Wang, R.; Englert, U.

Synthesis, photophysical properties and structures of organotin-Schiff bases utilizing aromatic amino acid from the chiral pool and evaluation of the biological perspective of a triphenyltin compound

Organotin(IV) compounds, Chiral Schiff bases, A375 (human melanoma) cell line, Molecular modelling

Journal of Inorganic Biochemistry, 2017, 168, 76-89; DOI:10.1016/j.jinorgbio.2016.12.001

Greene, L.; Elzey, B.; Franklin, M.; Fakayode, S. O.

Analyses of polycyclic aromatic hydrocarbon (PAH) and chiral-PAH analogues-methyl-β-cyclodextrin guest-host inclusion complexes by fluorescence spectrophotometry and multivariate regression analysis

Chemometrics-regression-analysis, Chiral analysis, Anthracene, 1-(9-Anthryl)-2,2,2-triflouroethanol, Methyl-β-cyclodextrin, Binding affinity, Thermodynamic properties

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, 2017, 174, 316-325; DOI:10.1016/j.saa.2016.11.047

Hashidzume, A.; Takashima, Y.; Yamaguchi, H.; Harada, A.

Cyclodextrin

Inclusion, Molecular recognition, Molecular machines, Molecular necklace, Molecular tube, Polypseudorotaxane, Polyrotaxane, Slow release, Solubilization, Stabilization

Reference Module in Chemistry, Molecular Sciences and Chemical Engineering, Reedijk, J. Ed., Elsevier, 2017; DOI:10.1016/B978-0-12-409547-2.13829-6

Linden, L.; Goss, K.-U.; Endo, S.

3D-QSAR predictions for α-cyclodextrin binding constants using quantum mechanically based descriptors

Inclusion complex, Structural isomers of aliphatic alcohols, Protein binding

Chemosphere, 2017, 169, 693-699; DOI:10.1016/j.chemosphere.2016.11.115

Maity, B.; Chatterjee, A.; Ahmed, S. A.; Seth, D.

Deciphering the perturbation effect of urea on the supramolecular host-guest interaction of biologically active hydrophobic molecule inside the nanocavity of

cyclodextrins

β-CD, γ-CD, Isothermal titration calorimetry, Fluorescence spectroscopy, Twisted intramolecular charge transfer, Coumarin derivative, Cavity diameter

Journal of Luminescence, 2017, 183, 238-250; DOI:10.1016/j.jlumin.2016.11.037

Martín, V. I.; Ostos, F. J.; Angulo, M.; Márquez, A. M.; López-Cornejo, P.; López-López, M.; Carmona, A. T.; Moyá, M. L.

Host-guest interactions between cyclodextrins and surfactants with functional groups at the end of the hydrophobic tail

Inclusion complexes, Aromatic substituents, Cationic surfactants, Dodecyltriethylammonium bromide

Journal of Colloid and Interface Science, 2017, 491, 336-348; DOI:10.1016/j.jcis.2016.12.040

Nassimbeni, L.; Báthori, N.

Thermal analysis

Differential scanning calorimetry, Guest exchange, Pharmaceuticals, Solid-state kinetics, Thermodilatometry, Thermogravimetry, Thermomechanometry, Thermoptometry

Reference Module in Chemistry, Molecular Sciences and Chemical Engineering, Reedijk, J. Ed., Elsevier, 2016; DOI:10.1016/B978-0-12-409547-2.12492-8

Shouji, T.; Yamamoto, K.; ichi Kadokawa, J.

Chemoenzyamtic synthesis and self-assembling gelation behavior of amylose-grafted poly(γ-glutamic acid)

Enzymatic polymerization, Saccharide-peptide conjugate, Maltooligosaccharide, Self-assembling hydrogelation

International Journal of Biological Macromolecules, 2017, 97, 99-105; DOI:10.1016/j.ijbiomac.2017.01.001

Weiss, M. J.; O'shea, K. E.

Detailed NMR investigation of cyclodextrin-perfluorinated surfactant interactions in aqueous media

Remediation, Competition studies with adamantane-carboxylic acid and phenol, β-CD

Journal of Hazardous Materials, 2017, 329, 57-65; DOI:10.1016/j.jhazmat.2017.01.017

3. CDs in Drug Formulation

Aloisio, C.; Antimisiaris, S. G.; Longhi, M. R.

Liposomes containing cyclodextrins or meglumine to solubilize and improve the bioavailability of poorly soluble drugs

Complexes, Release, βCD, Methyl-βCD, HPβCD, Meglumine, Sulfamerazine, Indomethacin, Phosphatidylcholine, Cholesterol, Retention of vesicle encapsulated calcein

Journal of Molecular Liquids, 2017, 229, 106-113; DOI:10.1016/j.molliq.2016.12.035

Aytac, Z.; Uyar, T.

Core-shell nanofibers of curcumin/cyclodextrin inclusion complex and polylactic acid: Enhanced water solubility and slow release of curcumin

Electrospinning, Hydroxypropyl-β-cyclodextrin, Antioxidant activity

International Journal of Pharmaceutics, 2017, 518, 177-184; DOI:10.1016/j.ijpharm.2016.12.061

Bani-Yaseen, A. D.

Computational molecular perspectives on the interaction of propranolol with β-cyclodextrin in solution: Towards the drug-receptor mechanism of interaction

Orientation of guest, Inclusion complex, β-Blocker, Supramolecular interaction, Dispersion forces, Hydrogen bonding, SQM, DFT, ONIOM

Journal of Molecular Liquids, 2017, 227, 280-290; DOI:10.1016/j.molliq.2016.12.023

Bergh, V. J. V.; Tønnesen, H. H.

Interactions and solubilization of 5, 10, 15, 20-tetrakis(4-hydroxyphenyl)porphyrin with poloxamer 407 and β-cyclodextrin-derivatives in binary and ternary systems

Photosensitizer, HPβCD, MethylβCD

Journal of Drug Delivery Science and Technology, 2017, 37, 51-60; DOI:10.1016/j.jddst.2016.11.004

Borsari, C.; Santarem, N.; Torrado, J.; Olías, A. I.; Corral, M. J.; Baptista, C.; Gul, S.; Wolf, M.; Kuzikov, M.; Ellinger, B.; Witt, G.; Gribbon, P.; Reinshagen, J.; Linciano, P.; Tait, A.; Costantino, L.; Freitas-Junior, L. H.; Moraes, C. B.; dos Santos, P. B.; Alcântara, L. M.; Franco, C. H.; Bertolacini, C. D.; Fontana, V.; Nevado, P. T.; Clos, J.; Alunda, J. M.; da Silva, A. C.; Ferrari, S.; Costi, M. P.

Methoxylated 2'-hydroxychalcones as antiparasitic hit compounds

Trypanosoma brucei, Trypanosoma cruzi, Leishmania infantum, Early toxicity studies, Hydroxypropyl-β-cyclodextrin formulation, Oral bioavailability

European Journal of Medicinal Chemistry, 2017, 126, 1129-1135; DOI:10.1016/j.ejmech.2016.12.017

Bouzitouna, A.; Khatmi, D.; Yahia, O. A.

A hybrid MP2/DFT scheme for N-nitroso-N-(2-chloroethyl)-N′-sulfamoylprolinate/β-cyclodextrin supramolecular structure: AIM, NBO analysis

HOMO-LUMO analysis, ONIOM2, PM7, Antineoplastic drug, Conformational analysis, Hydrogen bonds

Computational and Theoretical Chemistry, 2017, 1100, 18-27; DOI:10.1016/j.comptc.2016.12.004

Chen, M.; Wu, Q.; Jiang, J.; Jin, X.; Liu, S.; Wang, M.; Zhao, C.

Preparation, characterization and *in vivo* evaluation of a formulation of dantrolene sodium with hydroxypropyl-β-cyclodextrin

Pharmacokinetics, UPLC/MS/MS method, Rats, Dissolution rate, Bioavailability

Journal of Pharmaceutical and Biomedical Analysis, 2017, 135, 153-159; DOI:10.1016/j.jpba.2016.12.022

Cugovčan, M.; Jablan, J.; Lovrić, J.; Cinčić, D.; Galić, N.; Jug, M.

Biopharmaceutical characterization of praziquantel cocrystals and cyclodextrin complexes prepared by grinding

Mechanochemical activation, Liquid assisted grinding, Citric acid, Malic acid, Salicylic acid, Tartaric acid, HPβCD, RAMEB, Photosability, Chemical stability, Biocompatibility, Dissolution, In vitro permeability

Journal of Pharmaceutical and Biomedical Analysis, 2017, 137, 42-53; DOI:10.1016/j.jpba.2017.01.025

Higashi, T.; Ohshita, N.; Hirotsu, T.; Yamashita, Y.; Motoyama, K.; Koyama, S.; Iibuchi, R.; Uchida, T.; Mieda, S.; Handa, K.; Kimoto, T.; Arima, H.

Stabilizing effects for antibody formulations and safety profiles of cyclodextrin polypseudorotaxane hydrogels

Physical stability, Antibody-based drugs, Polyethylene glycol, α-CD, γ-CD, Omalizumab, Palivizumab, Panitumumab, Ranibizumab, Plasma levels, Rats

Journal of Pharmaceutical Sciences, 2017, *In Press*; DOI:10.1016/j.xphs.2017.01.002

Hoffmeister, C. R.; Fandaruff, C.; da Costa, M. A.; Cabral, L. M.; Pitta, L. R.; Bilatto, S. E.; Prado, L. D.; Corrêa, D. S.; Tasso, L.; Silva, M. A. S.; Rocha, H. V.

Efavirenz dissolution enhancement III: Colloid milling, pharmacokinetics and electronic tongue evaluation

Bioavailability, Colloid mill, Spray or freeze-drying, Non-nucleoside reverse transcriptase inhibitor, HIV-1/AIDS, Cyclodextrins, Dendrimers, Polymeric nanoparticles

European Journal of Pharmaceutical Sciences, 2017, 99, 310-317; DOI:10.1016/j.ejps.2016.12.032

Jadhav, P.; Pore, Y.

Physicochemical, thermodynamic and analytical studies on binary and ternary inclusion complexes of bosentan with hydroxypropyl-β-cyclodextrin

Endothelin receptor antagonist, HPβCD, l-Arginine

Bulletin of Faculty of Pharmacy, Cairo University, 2016, *In Press*; DOI:10.1016/j.bfopcu.2016.12.004

Liu, B.; Li, H.; Xu, X.; Li, X.; Lv, N.; Singh, V.; Stoddart, J. F.; York, P.; Xu, X.; Gref, R.; Zhang, J.

Optimized synthesis and crystalline stability of γ-cyclodextrin metal-organic frameworks for drug adsorption

Elevated temperature, Size control, Captopril

International Journal of Pharmaceutics, 2016, 514, 212-219; DOI:10.1016/j.ijpharm.2016.09.029

Ma, X.; Zhou, N.; Zhang, T.; Hu, W.; Gu, N.

Self-healing pH-sensitive poly[(methyl vinyl ether)-alt-(maleic acid)]-based supramolecular hydrogels formed by inclusion complexation between cyclodextrin and adamantane

Drug delivery, Cell and gene therapy, Tissue engineering, Host polymer, Guest polymer

Materials Science and Engineering: C, 2017, 73, 357-365; DOI:10.1016/j.msec.2016.12.039

Mohtar, N.; Taylor, K. M.; Sheikh, K.; Somavarapu, S.

Design and development of dry powder sulfobutylether-β-cyclodextrin complex for pulmonary delivery of fisetin

Spray drying, Leucine, A549 cell line, Ethanol, Improved aerosolization properties

European Journal of Pharmaceutics and Biopharmaceutics, 2017, 113, 1-10; DOI:10.1016/j.ejpb.2016.11.036

Monteiro, A. P.; Caminhas, L. D.; Ardisson, J. D.; Paniago, R.; Cortés, M. E.; Sinisterra, R. D.

Magnetic nanoparticles coated with cyclodextrins and citrate for irinotecan delivery

Cancer, Iron oxide magnetic nanoparticles, β-Cyclodextrin, 2-Hydroxypropyl-β-cyclodextrin, Stable colloidal dispersion, Cytotoxicity

Carbohydrate Polymers, 2017, 163, 1-9; DOI:10.1016/j.carbpol.2016.11.091

Morgado, P. I.; Miguel, S. P.; Correia, I. J.; Aguiar-Ricardo, A.

Ibuprofen loaded PVA/chitosan membranes: A highly efficient strategy towards an improved skin wound healing

Drug delivery systems, Composite membranes, Wound dressings, In vivo assays, Supercritical carbon dioxide-assisted technique

Carbohydrate Polymers, 2017, 159, 136-145; DOI:10.1016/j.carbpol.2016.12.029

Oddo, L.; Cerroni, B.; Domenici, F.; Bedini, A.; Bordi, F.; Chiessi, E.; Gerbes, S.; Paradossi, G.

Next generation ultrasound platforms for theranostics

Microbubbles, Atomic Force Microscopy (AFM), Surface conjugation, Superparamagnetic iron oxide nanoparticles (SPIONs), Indocyanine green (ICG), Contrast agent, Specific targeting, Drug delivery, Cyclodextrins, Bioadhesion, Cyclic arginyl-glycyl-aspartic acid (RGD) peptide

Journal of Colloid and Interface Science, 2017, 491, 151-160; DOI:10.1016/j.jcis.2016.12.030

Reddy, D.; Choonara, Y. E.; Kumar, P.; Govender, M.; Indermun, S.; du Toit, L. C.; Meyer, L. C.; Pillay, V.

***In vivo* evaluation of an ultra-fast disintegrating wafer matrix: A molecular simulation approach to the ora-mucoadhesivity**

Oramucosal drug delivery, In vivo permeability, Diphenhydramine hydrochloride, Buccal tissue, Hydroxypropylcellulose, Poly(acrylic) acid, Sodium starch glycolate, β–cyclodextrin

Journal of Drug Delivery Science and Technology, 2017, 37, 123-133; DOI:10.1016/j.jddst.2016.12.008

Roy, K.; Bomzan, P.; Roy, M. C.; Roy, M. N.

Inclusion of tyrosine derivatives with α-cyclodextrin in aqueous medium of various pH conditions by surface tension, conductance, UV–Vis and NMR studies

Neurotransmitters, Complex, Apparent formation constant and thermodynamic parameters, Dopamine hydrochloride, Tyramine hydrochloride, (±)-Epinephrine hydrochloride

Journal of Molecular Liquids, 2017, 230, 104-112; DOI:10.1016/j.molliq.2016.12.104

Saleh, R. S.; Moustafa, M. A.

Recovery from rocuronium with sugammadex in children premedicated with dexamethasone for prevention of postoperative nausea and vomiting

Interaction between sugammadex and dexamethasone

Egyptian Journal of Anaesthesia, 2017, 33, 1-4; DOI:10.1016/j.egja.2016.11.005

Shaikh, V. R.; Hundiwale, D.; Patil, K. J.

A volumetric approach: Interactions of some local anesthetical drugs with α-cyclodextrin in aqueous solutions at 298.15 K

Density measurements, Apparent molar volumes, Infinite dilution volume values, Equilibrium constant, Encapsulation and host-guest interactions, Procaine hydrochloride, Lidocaine hydrochloride monohydrate, Tetracaine hydrochloride

The Journal of Chemical Thermodynamics, 2017, 107, 51-57; DOI:10.1016/j.jct.2016.12.023

Shityakov, S.; Salmas, R. E.; Durdagi, S.; Roewer, N.; Förster, C.; Broscheit, J.

Solubility profiles, hydration and desolvation of curcumin complexed with γ-cyclodextrin and hydroxypropyl-γ-cyclodextrin

Hydrogen bonds, Importance of water, In silico calculations (molecular docking, Monte Carlo (MC), and molecular dynamics simulations)

Journal of Molecular Structure, 2017, 1134, 91-98; DOI:10.1016/j.molstruc.2016.12.028

Terekhova, I. V.; Chislov, M. V.; Brusnikina, M. A.; Chibunova, E. S.; Volkova, T. V.; Zvereva, I. A.; Proshin, A. N.

Thermodynamics and binding mode of novel structurally related 1,2,4-thiadiazole derivatives with native and modified cyclodextrins

Complex formation, Solubility, Alzheimer's disease treatment, β- and γ-CDs

Chemical Physics Letters, 2017, 671, 28-36; DOI:10.1016/j.cplett.2017.01.010

Thiry, J.; Kok, M. G.; Collard, L.; Frère, A.; Krier, F.; Fillet, M.; Evrard, B.

Bioavailability enhancement of itraconazole-based solid dispersions produced by hot melt extrusion in the framework of the Three Rs rule

Three Rs rules (reduction, refinement and replacement), Biphasic dissolution test, Volumetric absorptive microsampling devices, Soluplus® (polyethylene glycol, polyvinyl acetate and polyvinylcaprolactame-based graft copolymer), Hydroxypropyl-β-cyclodextrin, In vitro–vivo correlation

European Journal of Pharmaceutical Sciences, 2017, 99, 1-8; DOI:10.1016/j.ejps.2016.12.001

Wei, Y.; Zhang, J.; Zhou, Y.; Bei, W.; Li, Y.; Yuan, Q.; Liang, H.

Characterization of glabridin/hydroxypropyl-β-cyclodextrin inclusion complex with robust solubility and enhanced bioactivity

FT-IR, PXRD, SEM, NMR, Increase in the radical-scavenging capacity and in the tyrosinase inhibitory activity

Carbohydrate Polymers, 2017, 159, 152-160; DOI:10.1016/j.carbpol.2016.11.093

Zhao, J.; He, Z.; Li, B.; Cheng, T.; Liu, G.

AND logic-like pH- and light-dual controlled drug delivery by surface modified mesoporous silica nanoparticles

β-CD, Imine bond, Azobenzene derivative, Opening/closing of the gate

Materials Science and Engineering: C, 2017, 73, 1-7; DOI:10.1016/j.msec.2016.12.056

4. CDs in Cell Biology

Chuaychu-noo, N.; Thananurak, P.; Chankitisakul, V.; Vongpralub, T.

Supplementing rooster sperm with Cholesterol-Loaded-Cyclodextrin improves fertility after cryopreservation

Breeds, Frozen semen, Post-thaw semen quality in chicken, Motility, Viability, Acrosome integrity, Mitochondrial function

Cryobiology, 2017, 74, 8-12; DOI:10.1016/j.cryobiol.2016.12.012

Abouelezz, M.; Montaser, A.; Hussein, M.; Eldesouky, A.; Badr, M.; Hegab, A.; Balboula, A.; Zaabel, S.

The effect of cholesterol loaded cyclodextrins on post-thawing quality of buffalo semen in relation to sperm DNA damage and ultrastructure

Spermatozoa, Protective effect, Inhibition of DNA damage, Manipulating lipid content

Reproductive Biology, 2016, *In Press*; DOI:10.1016/j.repbio.2016.12.001

Hu, X.; Yang, F.-F.; Liu, C.-Y.; Ehrhardt, C.; Liao, Y.-H.

***In vitro* uptake and transport studies of PEG-PLGA polymeric micelles in respiratory epithelial cells**

Micellar vesicles, Biological barriers, Translocation, Pulmonary drug delivery, Inhibitors of endocytic processes, Methyl-β-cyclodextrin

European Journal of Pharmaceutics and Biopharmaceutics, 2017, 114, 29-37; DOI:10.1016/j.ejpb.2017.01.004

Lin, Q.; Yang, Y.; Hu, Q.; Guo, Z.; Liu, T.; Xu, J.; Wu, J.; Kirk, T. B.; Ma, D.; Xue, W.

Injectable supramolecular hydrogel formed from α-cyclodextrin and PEGylated arginine-functionalized poly(l-lysine) dendron for sustained MMP-9 shRNA plasmid delivery

Gene transfection efficiency, Long-term gene therapy

Acta Biomaterialia, 2017, 49, 456-471; DOI:10.1016/j.actbio.2016.11.062

Rahimi, M.; Regan, D.; Arroyo, M.; Subramaniam, A. B.; Stone, H. A.; Staykova, M.

Shape transformations of lipid bilayers following rapid cholesterol uptake

Cyclodextrin used as a cholesterol donor

Biophysical Journal, 2016, 111, 2651-2657; DOI:10.1016/j.bpj.2016.11.016

Salmon, V. M.; Castonguay, F.; Demers-Caron, V.; Leclerc, P.; Bailey, J. L.

Cholesterol-loaded cyclodextrin improves ram sperm cryoresistance in skim milk-extender

Osmotic tolerance, Cold shock, Artificial insemination, Cryosurvival

Animal Reproduction Science, 2017, 177, 1-11; DOI:10.1016/j.anireprosci.2016.11.011

Salmon, V. M.; Leclerc, P.; Bailey, J. L.

Novel technical strategies to optimize cryopreservation of goat semen using cholesterol-loaded cyclodextrin

Sperm conservation, Resistance to seminal plasma damage

Cryobiology, 2017, 74, 19-24; DOI:10.1016/j.cryobiol.2016.12.010

Shim, Y.-J.; Tae, Y.-K.; Kang, B.-H.; Park, J.-S.; Jeon, S.-Y.; Min, B.-H.

Toll-like receptor 4 signaling is required for clusterin-induced tumor necrosis factor-α secretion in macrophage

Pretreatment with methyl-β-cyclodextrin, Lipid raft

Biochemical and Biophysical Research Communications, 2017, 482, 1407-1412; DOI:10.1016/j.bbrc.2016.12.049

5. CDs in Food, Cosmetics and Agrochemicals

Ho, T. M.; Truong, T.; Bhandari, B.

Chapter 5 - Spray-drying and non-equilibrium states/glass transition

Food powders (crystalline or amorphous), Spray-dried amorphous α-cyclodextrin powders

Non-Equilibrium States and Glass Transitions in Foods, Bhandari, B.; Roos, Y. H. Eds., Woodhead Publishing, 2017, 111-136; DOI:10.1016/B978-0-08-100309-1.00008-0

Kfoury, M.; Landy, D.; Ruellan, S.; Auezova, L.; Greige-Gerges, H.; Fourmentin, S.

Nootkatone encapsulation by cyclodextrins: Effect on water solubility and photostability

Encapsulation efficiency, Formation constant, Release, Insect repellent activity, Multiple headspace extraction

Food Chemistry, 2016, *In Press*; DOI:10.1016/j.foodchem.2016.12.086

Liu, L.; Xu, J.; Zheng, H.; Li, K.; Zhang, W.; Li, K.; Zhang, H.

Inclusion complexes of laccaic acid A with β-cyclodextrin or its derivatives: Phase solubility, solubilization, inclusion mode, and characterization

Natural colorant, Food and textile industry, HP-β-CD, Me-β-CD, β-CD

Dyes and Pigments, 2017, 139, 737-746; DOI:10.1016/j.dyepig.2017.01.001

6. CDs for other Industrial Applications

Cao, H.; Wang, M.; Nie, K.; Zhang, X.; Lei, M.; Deng, L.; Wang, F.; Tan, T.

β-Cyclodextrin as an additive to improve the thermostability of *Yarrowia lipolytica* Lipase 2: Experimental and simulation insights

Molecular dynamic simulation, Thermosensitive region

Journal of the Taiwan Institute of Chemical Engineers, 2017, 70, 49-55; DOI:10.1016/j.jtice.2016.10.035

Dettmer, A.; Ball, R.; Boving, T. B.; Khan, N. A.; Schaub, T.; Sudasinghe, N.; Fernandez, C. A.; Carroll, K. C.

Stabilization and prolonged reactivity of aqueous-phase ozone with cyclodextrin

In-situ chemical oxidation (ISCO), Groundwater remediation, HPβCD:O_3 clathrate complex

Journal of Contaminant Hydrology, 2017, 196, 1-9; DOI:10.1016/j.jconhyd.2016.11.003

Ikotun, B.; Fanourakis, G.; Bhardwaj, S. M.

The effect of fly ash, β-cyclodextrin and fly ash-β-cyclodextrin composites on concrete workability and strength

Replacing cement, Compressive and tensile strengths

Cement and Concrete Composites, 2017, 78, 1-12; DOI:10.1016/j.cemconcomp.2016.12.008

Li, P.; Li, S.; Wang, Y.; Zhang, Y.; Han, G.-Z.

Green synthesis of β-CD-functionalized monodispersed silver nanoparticles with ehanced catalytic activity

Monodispersity, Reduction of p-nitrophenol by $NaBH_4$

Colloids and Surfaces A: Physicochemical and Engineering Aspects, 2017, 520, 26-31; DOI:10.1016/j.colsurfa.2017.01.034

Lin, L.; Sun, H.; Zhang, K.; Zhong, Y.; Cheng, Q.; Bian, X.; Xin, Q.; Cheng, B.; Feng, X.; Zhang, Y.

Novel affinity membranes with macrocyclic spacer arms synthesized via click chemistry for lysozyme binding

Bioseparation and purification, Clickable azide-cyclodextrin, Clickable alkyne ethylene-vinyl alcohol

Journal of Hazardous Materials, 2017, 327, 97-107; DOI:10.1016/j.jhazmat.2016.12.047

Liu, W.; Wu, Z.; Wang, Y.; Zheng, H.; Yin, H.

Modified β-CD-Cu ion complex and yam mucilage assisted batch foam fractionation for separating puerarin from Ge-gen (*Radix puerariae*)

Inclusion complex, Fluorescence sensitization, Carbon disulfide, Non-surface-active materials

Separation and Purification Technology, 2017, 175, 194-202; DOI:10.1016/j.seppur.2016.11.039

Rybnikova, V.; Singhal, N.; Hanna, K.

Remediation of an aged PCP-contaminated soil by chemical oxidation under flow-through conditions

Pentachlorophenol (PCP), Hydrogen peroxide, Methyl-β-cyclodextrin

Chemical Engineering Journal, 2017, 314, 202-211; DOI:10.1016/j.cej.2016.12.120

Sakthivel, P.; Velusamy, P.

Modification of the photocatalytic performance of various metal oxides by the addition of β-cyclodextrin under visible light irradiation

Photodecoloration, Neutral Red, β-CD, CeO_2, TiO_2, ZnO

Journal of Water Process Engineering, 2016, *In Press*; DOI:10.1016/j.jwpe.2016.10.009

Taka, A. L.; Pillay, K.; Mbianda, X. Y.

Nanosponge cyclodextrin polyurethanes and their modification with nanomaterials for the removal of pollutants from waste water: A review

Nanosorbents, Adsorption capacity, Nanotoxicity, Carbon nanotubes, TiO_2 and Silver nanoparticles

Carbohydrate Polymers, 2017, 159, 94-107; DOI:10.1016/j.carbpol.2016.12.027

Triki, M.; Tanazefti, H.; Kochkar, H.

Design of β-cyclodextrin modified TiO_2 nanotubes for the adsorption of Cu(II): Isotherms and kinetics study

Cu(II)-ammonia complexes, Langmuir isotherm

Journal of Colloid and Interface Science, 2017, 493, 77-84; DOI:10.1016/j.jcis.2017.01.028

Wang, N.; NuLi, Y.; Su, S.; Yang, J.; Wang, J.

Effects of binders on the electrochemical performance of rechargeable magnesium batteries

Anodic stability, Polyvinylidene fluoride, Water-soluble poly(acrylic acid), Poly(vinyl alcohol), Gelatin, Sodium alginate, β-CD

Journal of Power Sources, 2017, 341, 219-229; DOI:10.1016/j.jpowsour.2016.12.003

Yang, Z.; Zhang, X.; Fang, Y.; Rui, Z.; Ji, H.

Efficient oxidation of cinnamon oil to natural benzaldehyde over β-cyclodextrin-functionalized MWCNTs

Selective oxidation, Catalytic oxidation, Multi-walled carbon nanotube, Synergistic effect

Chinese Journal of Catalysis, 2016, 37, 2086-2097; DOI:10.1016/S1872-2067(16)62543-3

7. CDs in Sensing and Analysis

Carabajal, M. D.; Arancibia, J. A.; Escandar, G. M.

Excitation-emission fluorescence-kinetic data obtained by Fenton degradation. Determination of heavy-polycyclic aromatic hydrocarbons by four-way parallel factor analysis

Third-order advantage, Fenton reaction, Benzo[a]pyrene, Dibenz[a,h]anthracene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benz[a]anthracene, Methyl-β-cyclodextrin

Talanta, 2017, 165, 52-63; DOI:10.1016/j.talanta.2016.12.030

DUAN, J.; ZHUO, S.; YAO, F.-J.; ZHANG, Y.-N.; KANG, X.-F.

A single-molecule mycobacterium smegmatis porin A protein nanopore sensor for host-guest chemistry

1-Amantadine hydrochloride, Per-6-amino-β-cyclodextrin, Non-covalent adapter

Chinese Journal of Analytical Chemistry, 2016, 44, 1801-1807; DOI:10.1016/S1872-2040(16)60976-3

Han, J.; Li, Y.; Feng, J.; Li, M.; Wang, P.; Chen, Z.; Dong, Y.

A novel sandwich-type immunosensor for detection of carcino-embryonic antigen using silver hybrid multiwalled carbon nanotubes/manganese dioxide

β-Cyclodextrin/multiwalled carbon nanotubes, Dual signal amplification

Journal of Electroanalytical Chemistry, 2017, 786, 112-119; DOI:10.1016/j.jelechem.2017.01.021

He, L.; Xu, Z.; Hirokawa, T.; Shen, L.

Simultaneous determination of aliphatic, aromatic and heterocyclic biogenic amines without derivatization by capillary electrophoresis and application in beer analysis

UV absorbing probe, Imidazole, α-CD

Journal of Chromatography A, 2017, 1482, 109-114; DOI:10.1016/j.chroma.2016.12.067

Hu, T.; Na, W.; Yan, X.; Su, X.

Sensitive fluorescence detection of ATP based on host-guest recognition between near-infrared β-Cyclodextrin-$CuInS_2$ QDs and aptamer

Fluorescent aptamer-based sensor

Talanta, 2017, 165, 194-200; DOI:10.1016/j.talanta.2016.09.064

Mahpishanian, S.; Sereshti, H.

One-step green synthesis of β-cyclodextrin/iron oxide-reduced graphene oxide nanocomposite with high supramolecular recognition capability: Application for vortex-assisted magnetic solid phase extraction of organochlorine pesticides residue from honey samples

Gas chromatography, High water dispersability, Magnetic responsivity, Molecular selectivity

Journal of Chromatography A, 2017, 1485, 32-43; DOI:10.1016/j.chroma.2017.01.035

Moldoveanu, S. C.; David, V.

Chapter 10 - Stationary phases and columns for chiral chromatography

Cellulose chiral phases, Crown ether chiral phases, Protein chiral phases, Cyclodextrin and cyclofructan chiral phases, Macrocyclic antibiotics, Pirkle phase

Selection of the HPLC Method in Chemical Analysis, Moldoveanu, S. C.; David, V. Eds., Elsevier, 2017, 363-376; DOI:10.1016/B978-0-12-803684-6.00010-X

Palanisamy, S.; Thangavelu, K.; Chen, S.-M.; Velusamy, V.; Chang, M.-H.; Chen, T.-W.; Al-Hemaid, F. M.; Ali, M. A.; Ramaraj, S. K.

Synthesis and characterization of polypyrrole decorated graphene/β-cyclodextrin composite for low level electrochemical detection of mercury (II) in water

Screen printed carbon electrode, Health and environment, Differential pulse voltammetry

Sensors and Actuators B: Chemical, 2017, 243, 888-894; DOI:10.1016/j.snb.2016.12.068

Peng, L.-Q.; Ye, L.-H.; Cao, J.; xu Chang, Y.; Li, Q.; An, M.; Tan, Z.; Xu, J.-J.

Cyclodextrin-based miniaturized solid phase extraction for biopesticides analysis in water and vegetable juices samples analyzed by ultra-high-performance liquid chromatography coupled with quadrupole time-of-flight mass spectrometry

HP-β-CD

Food Chemistry, 2017, 226, 141-148; DOI:10.1016/j.foodchem.2017.01.006

Qin, X.; Xu, A.; Liu, L.; Sui, Y.; Li, Y.; Tan, Y.; Chen, C.; Xie, Q.

Selective staining of CdS on ZnO biolabel for ultrasensitive sandwich-type amperometric immunoassay of human heart-type fatty-acid-binding protein and immunoglobulin G

In situ microliter-droplet anodic stripping voltammetry, ZnO-multiwalled carbon nanotubes, β-Cyclodextrin-graphene sheets, Glassy carbon electrode, Immunoelectrode

Biosensors and Bioelectronics, 2017, 91, 321-327; DOI:10.1016/j.bios.2016.12.051

Sun, J.; Bai, W.; Wang, Z.; Tang, B.

Host–guest supramolecular systems containing AIE-active building blocks

Aggregation-induced emission, Fluorescence, Crown ether, Cyclodextrin, Pillar[n]arene, Metal-organic framework, Restriction of intramolecular rotations and vibrations, Coordination, Self-assembling, Chemo-/biosensors

Reference Module in Chemistry, Molecular Sciences and Chemical Engineering, Reedijk, J. Ed., Elsevier, 2016; DOI:10.1016/B978-0-12-409547-2.12631-9

Xu, W.; Zhu, X.; Chu, Z.; Wang, Z.; Xiao, Z.; Huang, Z.

ScroBiculate sub-10 nm nanocavity arrays as effective sers substrate for the trace determination of 3,3′,4,4′-polychlorinated biphenyls

Surface enhanced Raman scattering, Thiolated β-Cyclodextrin

Applied Surface Science, 2017, 399, 711-715; DOI:10.1016/j.apsusc.2016.12.132

Ye, L.; Huang, N.-L.; Du, Y.-X.; Schneider, M.; Du, W.-D.

Succinyl-β-cyclodextrin modified gold biochip improved seroimmunological detection sensitivity for Lyme disease

Protein biochip, VlsE protein, Anti-VlsE IgG antibody

Analytica Chimica Acta, 2017, 953, 48-56; DOI:10.1016/j.aca.2016.11.050

Edited and produced by: CYCLOLAB
Homepage: www.cyclolab.hu
H-1525 P.O. 435, Budapest, Hungary
Tel.: (+361)347-6060
Fax.: (+361)347-6068
e-mail: cyclolab@cyclolab.hu