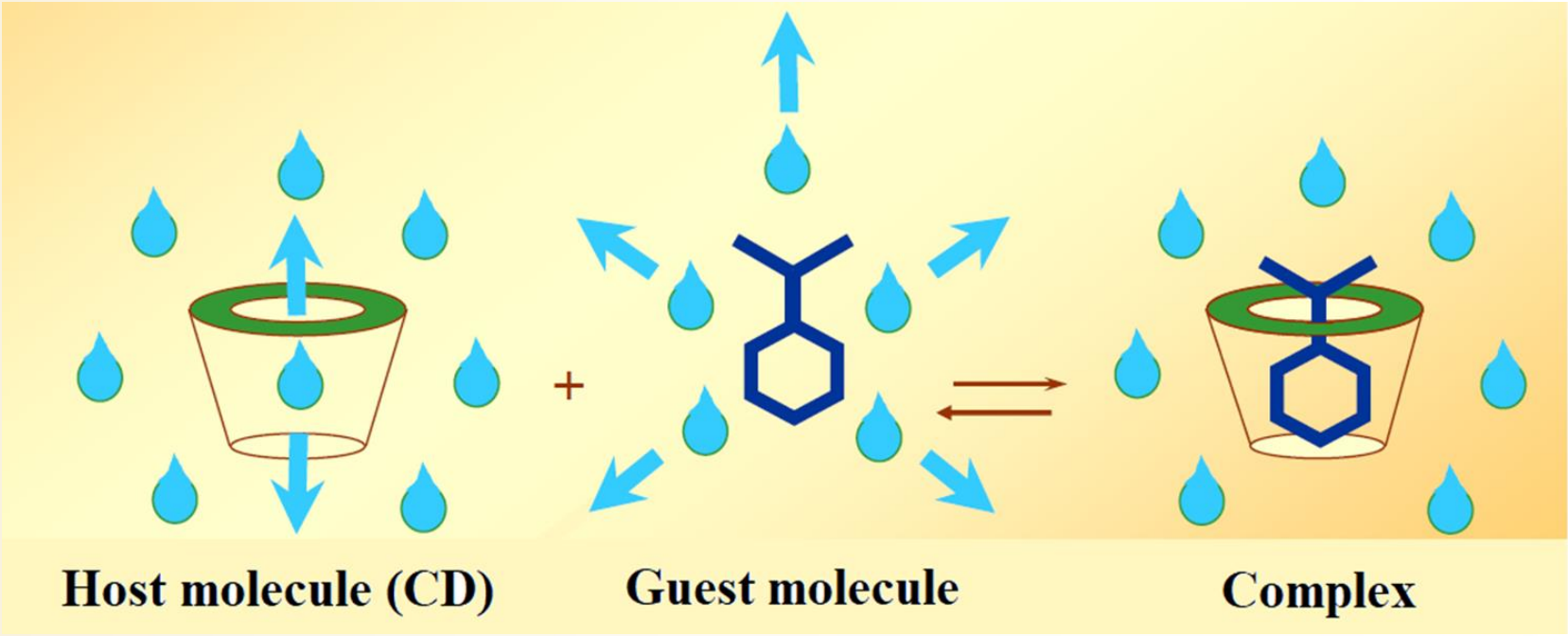
CYCLOLAB

The Cyclodextrin Company

Cyclodextrins in *Agricultural* use

What are cyclodextrins (CDs)?

- Composed of sugars
- Cyclic molecules
- Naturally occuring compounds
- Used in food, pharmaceuticals, drug delivery, chemical industries, agriculture, etc.



Why use cyclodextrins?

- improvement of the physico-chemical characteristics of pesticides (lipophilicity, phase-transition, wettability, vapour pressure, solubility, etc.)
- improvement of shelf life (stability)
- minimizing the container/content interaction in packaged formulations
- ensure homogeneity and content uniformity (molecular dispersity)
- enhancement of bioavailability and absorption
- reduction of the applied dose and thus the environmental pollution
- IP advantages (life-cycle management)

Who we are and what can we offer?

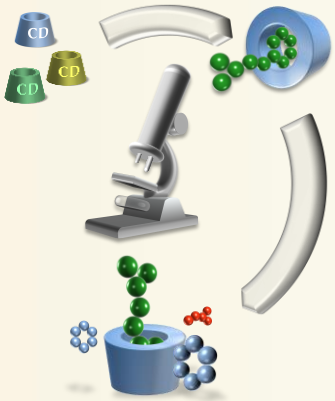
CycloLab is the world's only all-around Cyclodextrin Service Provider

Our services include:

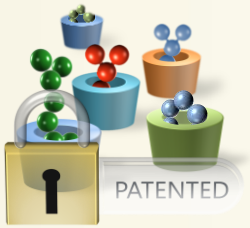
- **Supplying cyclodextrins for commercial products and product development**
- **Screening cyclodextrin derivatives to find the right candidate for target active ingredient.**
- **Providing formulation development services, composition optimization, stability assessment.**
- **Offering analytical services to characterize complexes and products.**
- **Preparing pilot-scale amounts for cyclodextrin-active complexes for development purposes.**
- **Assisting in compilation of regulatory documentation.**

For more information please click here

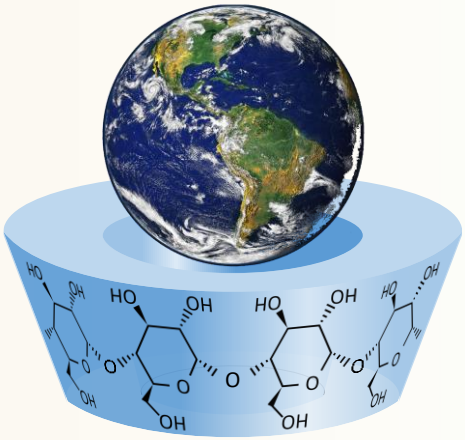
What is CycloLab?

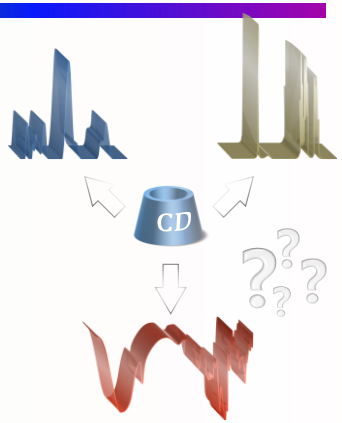


Early phase development



IP services & consultancy





Analytical services

Synthesis and production

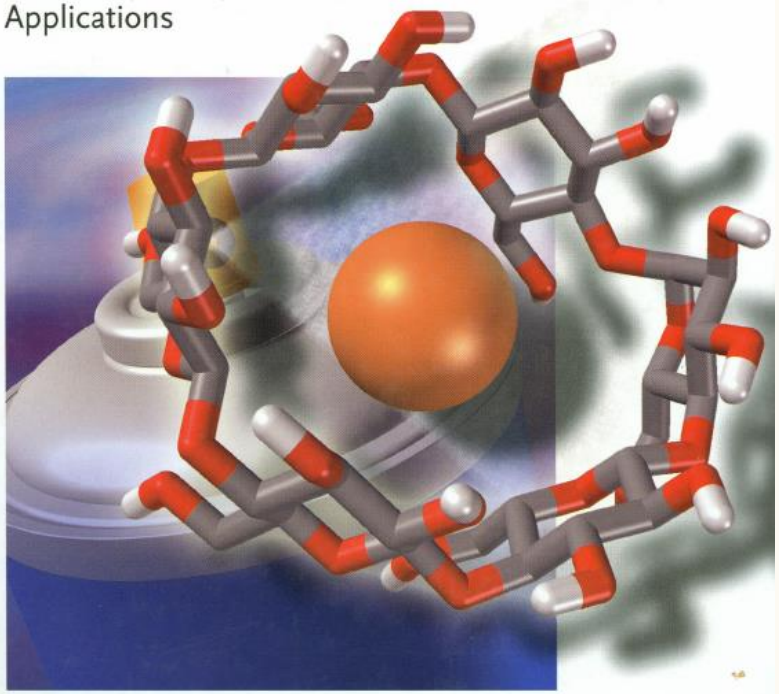
CDs in agricultural use

Edited by Helena Dodziuk

WILEY-VCH

Cyclodextrins and Their Complexes

Chemistry, Analytical Methods, Applications



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Application of Cyclodextrins in Agrochemistry

Esmeralda Morillo

The ability of cyclodextrins, CyDs, to form inclusion complexes with a wide variety of hydrophobic guest molecules has been used in agriculture. Their ability to alter the physical, chemical, and biological properties of guest molecules has been used for the preparation of new formulations of pesticides. CyDs form complexes with a wide variety of agricultural chemicals including herbicides, insecticides, fungicides, repellents, pheromones, and growth regulators [1, 2].

Each CyD has its own ability to form inclusion complexes with specific pesticides, depending on a proper fit of the pesticide molecule into the hydrophobic CyD cavity. The principal advantage is that the binding of pesticide molecules within the host molecule is not fixed or permanent but rather is a dynamic equilibrium. Dissociation of the inclusion complex is a relatively rapid process usually driven by a large increase in the number of water molecules in the surrounding environment [3].

CDs in agricultural use

Pesticide load and water content of cyclodextrin complexed liquid pesticides converted into microcrystalline solids

pesticide	type of cyclodextrin used	equilibrium water content in solid form (%) by weight	pesticide content in the formulation (g/100g)
Sumithrin	βCD	6.0	11.6
MGR-264	βCD	6.6	12.2
Malathion	αCD	7.0	10.8
Malathion	βCD	7.5	19.0
DDVP	βCD	5.9	16.0
DDVP	αCD	5.0	18.5
Dursban	βCD	8.2	14.2
Sulprofos	βCD	5.0	12.8
Sulprofos	αCD	4.3	13.7
Fenitrothion	βCD	5.8	14.0
DEET	βCD	6.0	10.7
DEET	αCD	4.6	12.2

CDs in agricultural use

Clumping tendency by screening test of adsorbed and complexed pesticides after a two-day storage (R.H. 95% at 25°C.) The results are weight percentages of passed and retained fractions of samples

Sample	pesticide content	passed fraction	retained fraction
Malathion/starch	20%	11%	89%
Malathion/βCD	19%	78%	22%
DDVP/starch	16%	9%	91%
DDVP/βCD	16%	86%	14%
Dursban/starch	15%	6%	94%
Dursban/βCD	14%	81%	19%

CDs in agricultural use

Thermal stability of insecticides (60°C)

formulation	remnant pesticide in percentage of the initial content				
	time zero	one week	two weeks	three weeks	four weeks
Fenithrothion /starch	100	82	70	58	52
Fenithrothion /αCD	100	90	84	68	64
Fenithrothion /βCD	100	100	96	90	90
Malathion /starch	100	78	70	67	63
Malathion /βCD	100	100	103	97	96
Malathion /αCD	100	100	100	101	98

CDs in agricultural use

Thermal stability of insecticides (25°C)

formulation	remnant pesticide in percentage of the initial content				
	time zero	6 months	12. months	18. months	24. months
Sumithion /starch	100	88	78	70	66
Sumithion /βCD	100	100	100	97	97
Malathion /starch	100	83	68	57	43
Malathion /βCD	100	98	100	97	98
Dursban /starch	100	88	87	67	70
Dursban /βCD	100	98	102	97	98

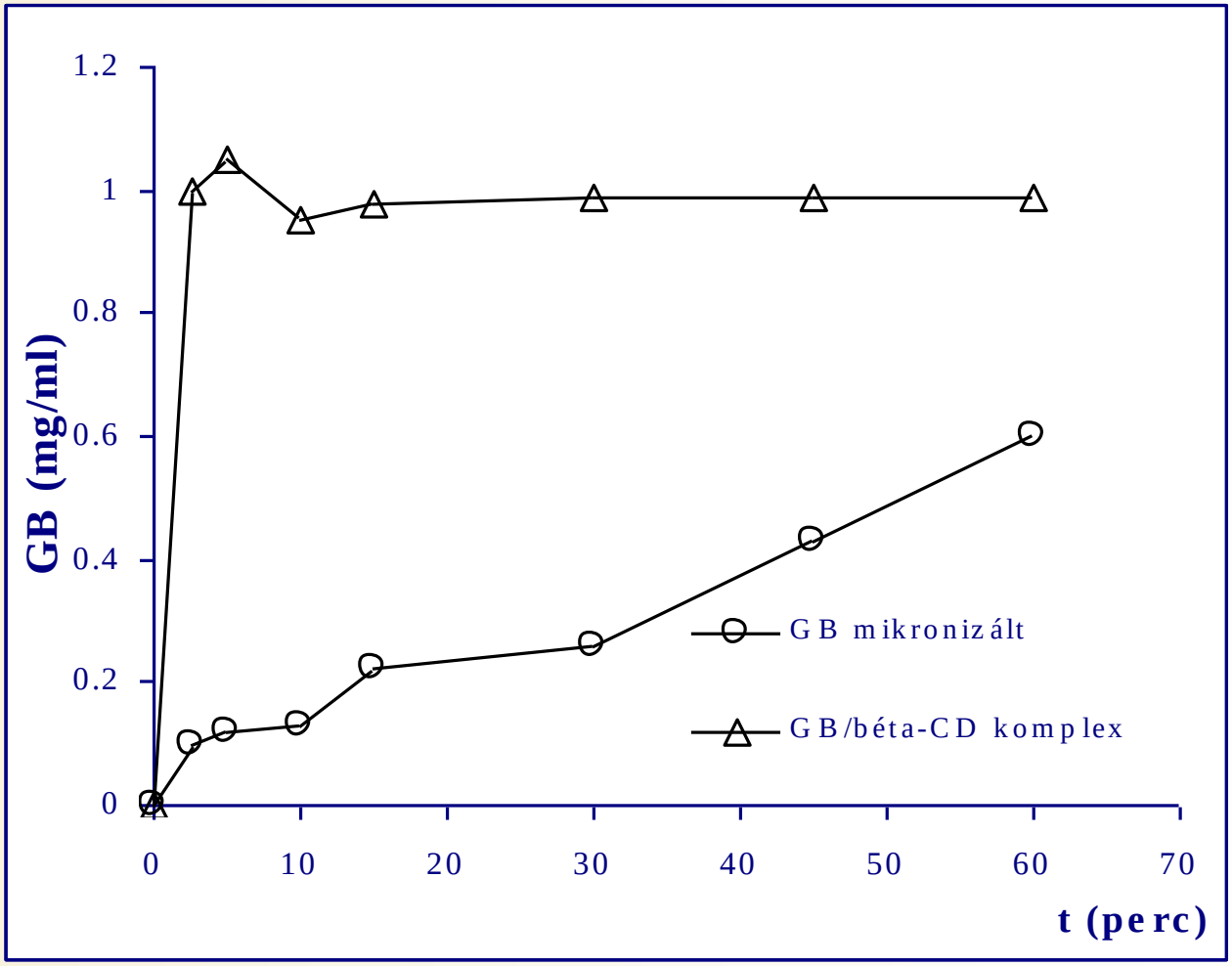
CDs in agricultural use

A few formulations developed

Sample	Pesticide load (%)	water content by titration (%)	Loss on drying (%)
Malathion/bCD	20.8	6.7	7.4
Chlorpyriphos/bCD	23.0	7.0	7.7
Sumithion/bCD	19.1	8.3	9.0
DDVP/bCD	16.0	7.8	8.0
Sulprofos/bCD	22.2	8.8	9.4

CDs in agricultural use

Gibberellic acid



Comparison of micronized and CD-complexed formulations for GB-release

Other possibilites for cyclodextrin use

Vitamins and cyclodextrins[3]

- β-cyclodextrins improve pharmacokinetics of α- tocopherol in heifers
- Cyclodextrin encapsulated vitamin K (K_1, K_2) can reduce osteochondral effects in animals

Essential oils and cyclodextrins

Several patents are about essential oil formulations with cyclodextrins, e.g.:

- Camphor oil (-respiratory stimulant)
- Lemon oil (-flavor enhancer)
- Cinnamon oil (-flavor enhancer)
- Garlic oil (-antimicrobial)

Effects of cyclodextrin complexes on methane production in heifers

- The β-cyclodextrin complex with guest materials appears to be a promising solution to mitigate methane emissions without reducing energy intake.

Cyclodextrins in feeds

- Cyclodextrins were shown to have certain advantageous effects on feeds like inhibition of certain mycotoxins, of taste/odor masking for additives

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