

Bacterial strain *Rhodococcus* sp. ED55 degrades endocrine disrupting chemicals in wastewater



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PORTO

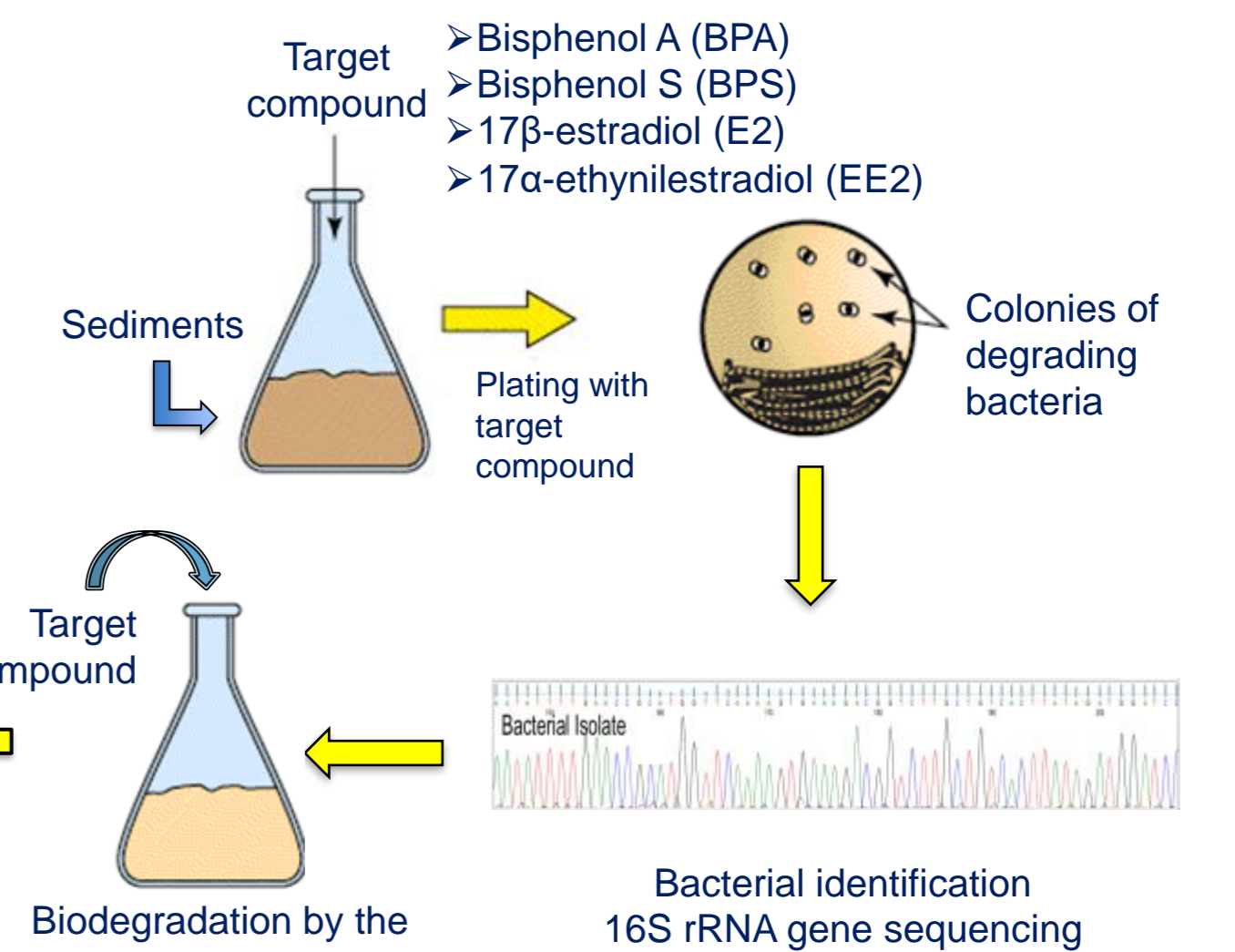
Introduction

Endocrine disrupting chemicals (EDCs) is a group of chemicals that can alter the hormonal and homeostatic systems of organisms. An increasing concern on possible environmental and human health effects is due to evidence of negative effects as a result of exposure to very low concentrations [1]. There is a long list of EDCs, which include natural and synthetic estrogens and industrial chemicals such as bisphenol A. It is commonly accepted that the major source of EDCs to the environment is wastewater treatment plants (WWTPs) effluents, due to their inefficiency to remove this kind of pollutants [2]. Bioaugmentation, the process of adding selected bacterial strains to improve degradation of recalcitrant compounds, is a promising technique to improve removal of pollutants in WWTP. A bacterial strain, *Rhodococcus* sp. ED55, isolated from WWTP in Coloane (Macao), for its ability to degrade EDCs, can potentially be applied in bioaugmentation strategies for ameliorating treatment of wastewater contaminated with EDCs.

Isolation of *Rhodococcus* sp. ED55

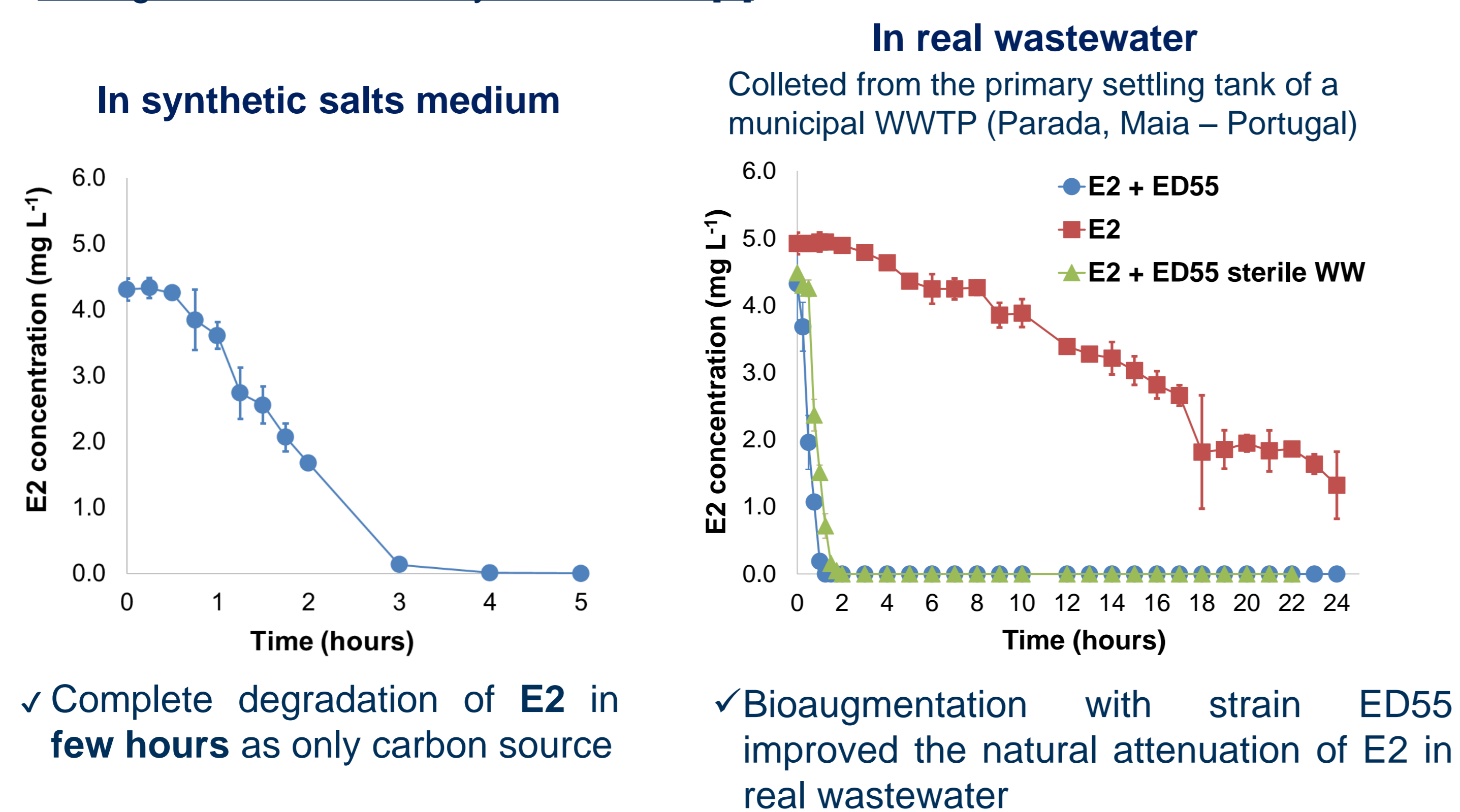
Isolation from sediments near the discharge point of Coloane WWTP, Macao [3]

Isolate	Closest relative (accession no.)	Similarity (%)	EDs-degradation (%)			
			EE2	E2	BPA	BPS
ED15	<i>Achromobacter xylosoxidans</i> strain CD005A	99	34,0	54,9	1	5,5
ED17	<i>Stenotrophomonas maltophilia</i> strain QDPW 2.4.3	97	-	-	-	-
ED19	<i>Pseudomonas putida</i> strain LPK411	98	28,0	53,7	1,78	10,2
ED24	<i>Gordonia terrae</i> strain IFM 10548	98	35,1	52,8	0,8	5,9
ED38	<i>Paenibacillus</i> sp. 112-2.1.11	98	-	-	-	21,9
ED55	<i>Rhodococcus ruber</i> strain TH-22	100	67,4	79,4	23,2	33,5
ED63	<i>Staphylococcus</i> sp. strain Aclim21	99	0	27,7	20,4	19,2
ED64	<i>Achromobacter denitrificans</i> strain SMV191H5	99	-	-	-	19,0
ED70	<i>Alicyclobacillus</i> sp. UFSH	99	52,2	81,9	3,1	17,8
ED73	<i>Paenibacillus</i> sp. strain KDS	99	-	-	-	-
ED86	<i>Curtobacterium</i> sp. strain WP-1	98	67,4	55,2	8,5	11,1
ED89	<i>Curtobacterium</i> sp. TCOB-5	99	25,2	55,7	7,4	10,2
ED95	<i>Pseudomonas putida</i> strain V18-23	96	39,9	72,8	0	9,5
ED96	<i>Pseudomonas phycosphaerica</i> strain SL#02	99	-	-	-	-
ED106	<i>Ochrobactrum caryi</i> strain HB1	97	6,3	49,3	2,8	7,2
ED113	<i>Chryseobacterium</i> strain USMAA1020	99	60,9	100	0	-
ED115	<i>Alicyclobacillus</i> sp. R-24604	99	-	-	-	-
ED117	<i>Xanthobacter</i> sp. strain DMO-3	97	28,8	76,8	2,8	14,3
ED136	<i>Chitinophaga arvensicola</i> strain B10	98	-	-	-	-
ED138	<i>Microbacterium</i> sp. strain Aclim-49	97	-	-	-	-
ED158	<i>Curtobacterium</i> strain LS-1-1-1	97	-	-	-	-
ED174	<i>Pseudomonas phycosphaerica</i> strain ZYC13-1	97	33,1	65,7	9,6	11,4
ED185	<i>Alcaligenes faecalis</i> strain O1R4	97	64,7	62,0	4,4	11,4
ED190	<i>Achromobacter</i> sp. QEBR408	99	61,0	63,2	0	9,2
ED206	<i>Alcaligenes faecalis</i> strain UW19	94	58,9	65,3	1,8	3,3
ED209	<i>Paenibacillus lanatus</i> strain JCM 9073	96	39,0	43,8	-	11,4
ED210	<i>Microbacterium</i> sp. strain 4	98	-	-	-	-



17β-estradiol biodegradation by *Rhodococcus* sp. ED55

The natural hormone, 17β-estradiol (E2) was chosen as model compound to study biodegradation of EDCs by strain ED55 [4]



✓ Complete degradation of E2 in few hours as only carbon source

✓ Bioaugmentation with strain ED55 improved the natural attenuation of E2 in real wastewater

Evaluation of toxicity before and after E2 biodegradation by strain ED55

Evaluation of whole sample toxicity – Bioluminescence inhibition (%)

	WW sterile	WW not sterile
Before degradation assay	55,5	50,2
After (without ED55)	49,2	12,6
After (with ED55)	2,3	0

Elimination of the toxicity of the treated effluent

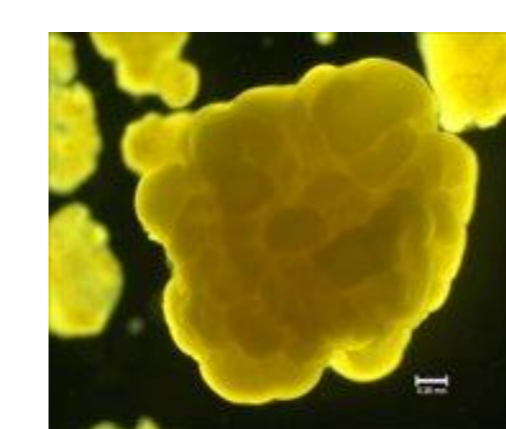
Evaluation of whole sample estrogenicity – S-YES assay (EEQ)

	WW sterile	WW not sterile	MM
Before degradation assay	> 400	> 400	352,2
After (without ED55)	> 400	< LOD	> 400
After (with ED55)	126,3	< LOD	124,9

Decrease in the estrogenic activity after biodegradation

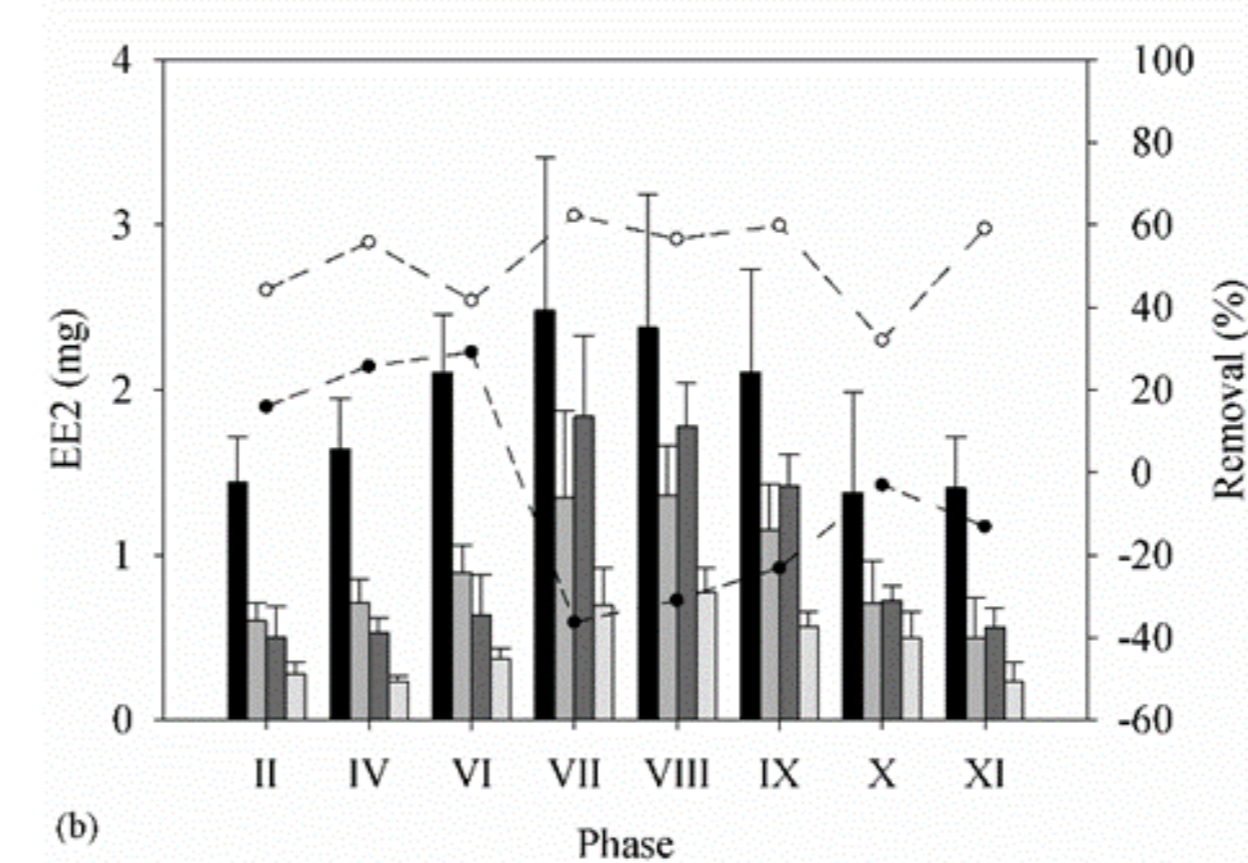
AGS bioaugmented with *Rhodococcus* sp. ED55

Strain ED55 was used in a bioreactor to treat wastewater containing EDCs [5]

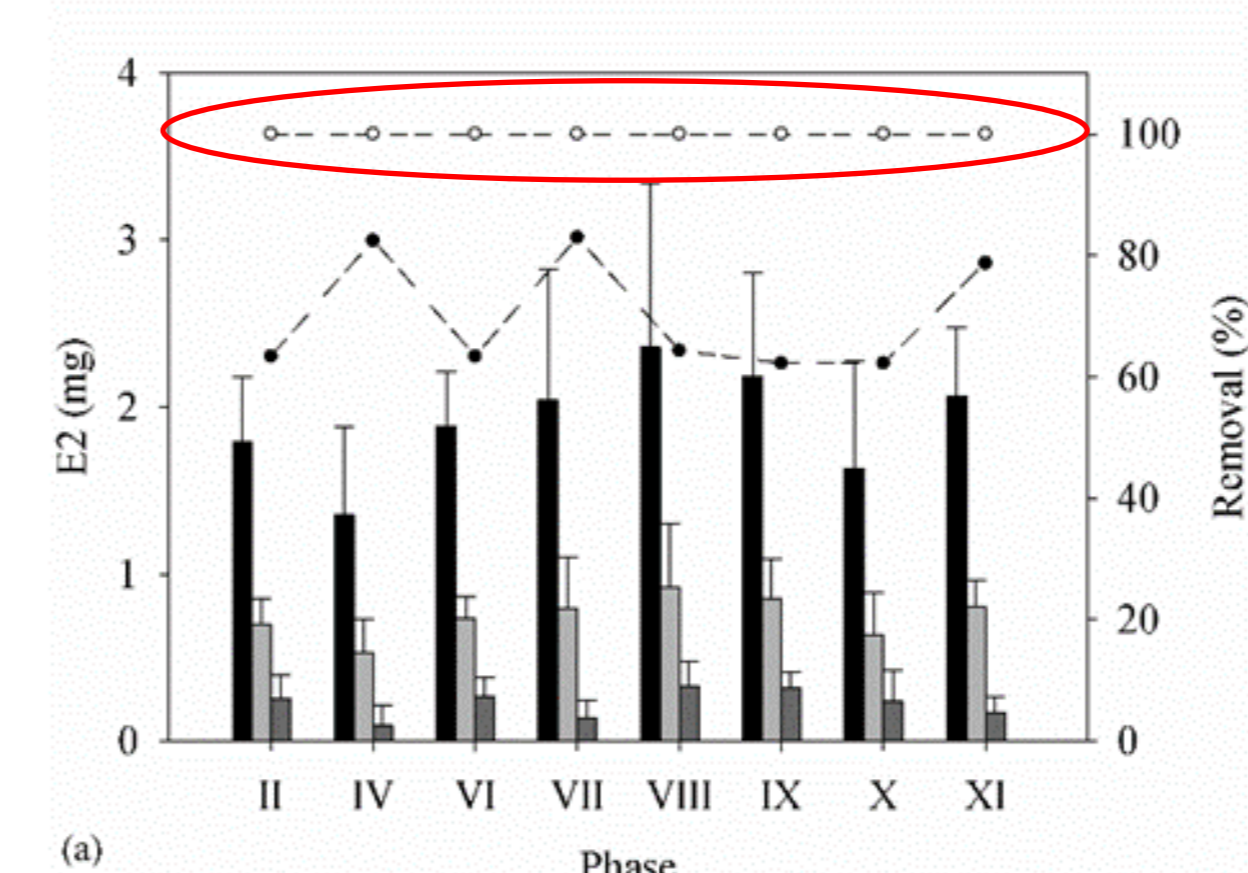


Aerobic granular sludge (AGS) is a technology now largely adopted in WWTP

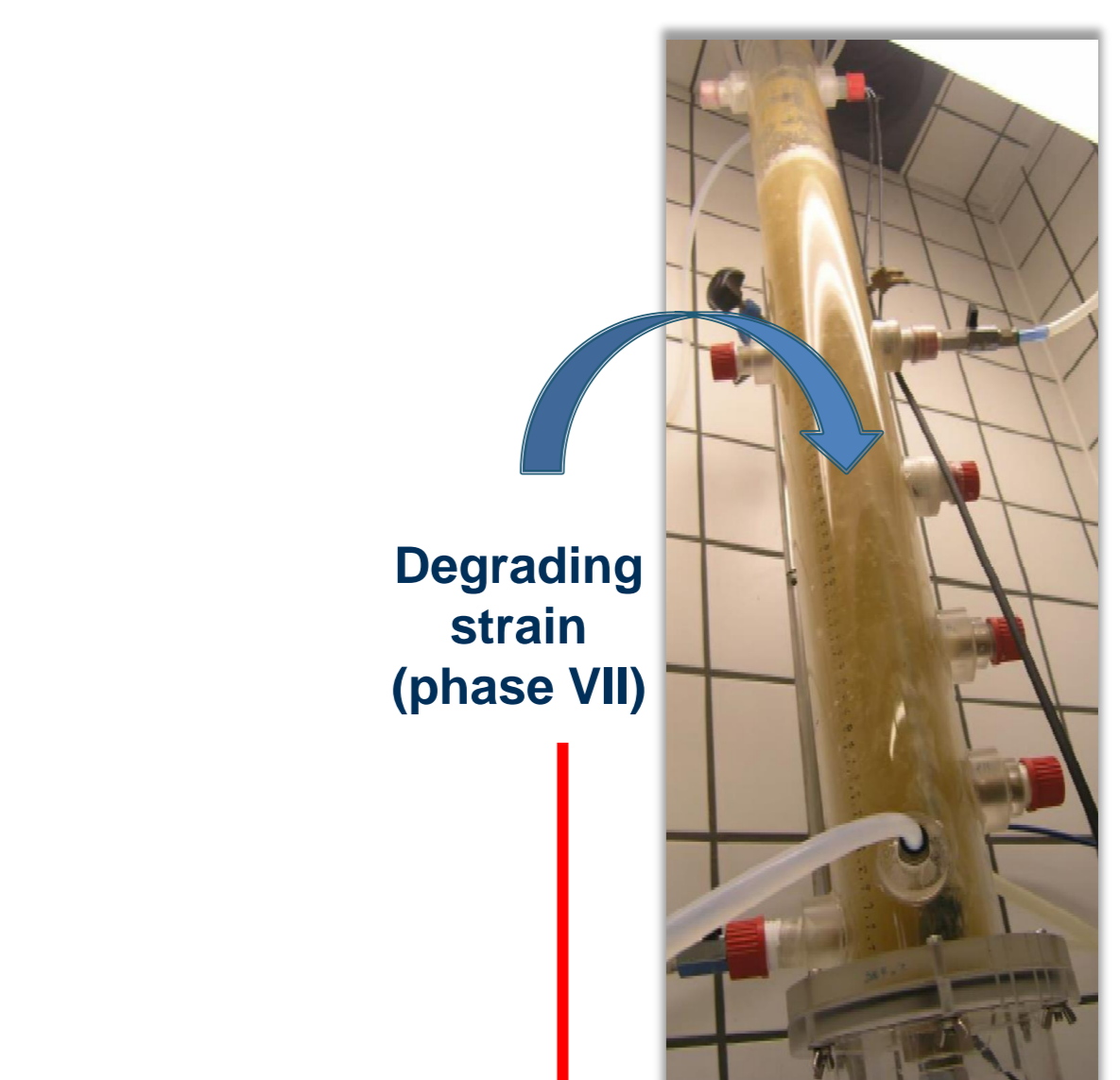
Synthetic saline wastewater
+
17β-estradiol (E2), 17α-ethynylestradiol (EE2) and bisphenol-A (BPA)
+
Bioaugmentation with *Rhodococcus* sp. ED55 (phase VII)



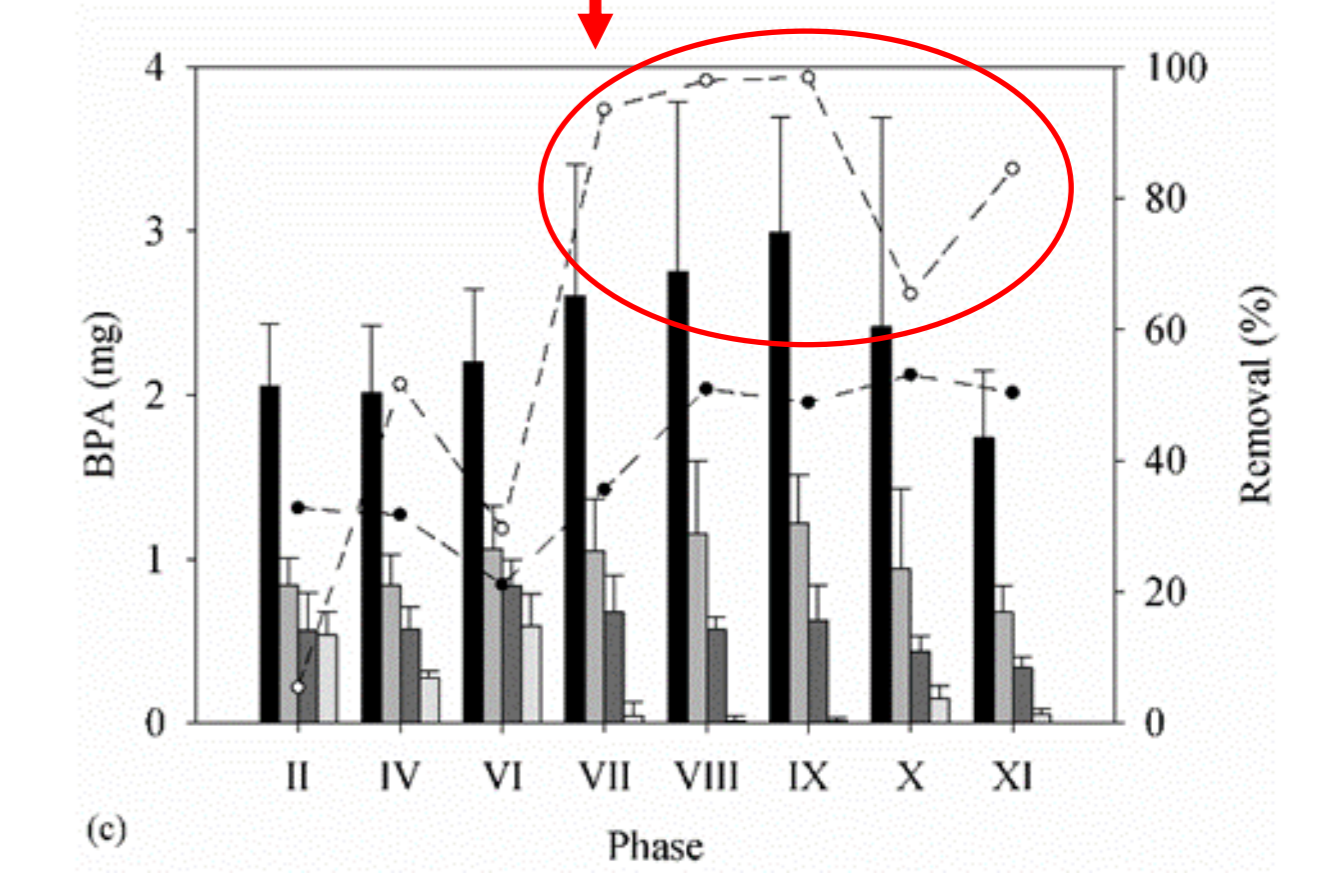
✓ EE2 adsorption/desorption



✓ E2 biodegradation 100%



Degrading strain (phase VII)



✓ BPA biodegradation 51 – 95%

Improved after bioaugmentation

■ Influent
■ After anaerobic feeding – theoretical
■ After anaerobic feeding - measured mass
□ Effluent
(*) Anaerobic removal
(c) Removal under aeration

References

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Conclusions

- A bacterial strain identified as *Rhodococcus* sp. ED55 was isolated from the sediments of discharge point of WWTP located in Macao;
- *Rhodococcus* sp. ED55 was able to degrade E2 in synthetic medium and in real wastewater;
- Bioaugmentation with strain ED55 improved natural E2 attenuation in real wastewater;
- Biodegradation is accompanied by removal of toxicity and decrease of estrogenicity;
- Bioaugmentation of an AGS reactor with strain ED55 improved biodegradation of BPA.