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Mechanisms implied in *Escherichia coli* removal during wastewater treatment

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Background

Wastewater treatment reduces environmental contamination:

- removing gross solids and mitigating its polluting effect
- reducing the number of indicator organisms and pathogens

Recycling of sludge as an organic fertilizer is environment friendly but:

- some pathogens can be present (viruses, bacteria and protozoa) (8)
- these microorganisms could be concentrated in sludge

Materials and methods

Biological model: *Escherichia coli* ABC*gfp,* isolated from wastewater (Crispijana WWTP) and modified to express GFP protein. This strain was indistinguishable from the parental non-tagged strain with respect to growth and behavior in sterilized wastewater (6).

Wastewater samples; from the Crispijana wastewater treatment plant (WWTP) (5).

Laboratory-scale activated-sludge unit (ASU) fed with influent and sludge from Crispijana WWTP. Similar working conditions for Crispijana WWTP and ASU.

Aim of the work

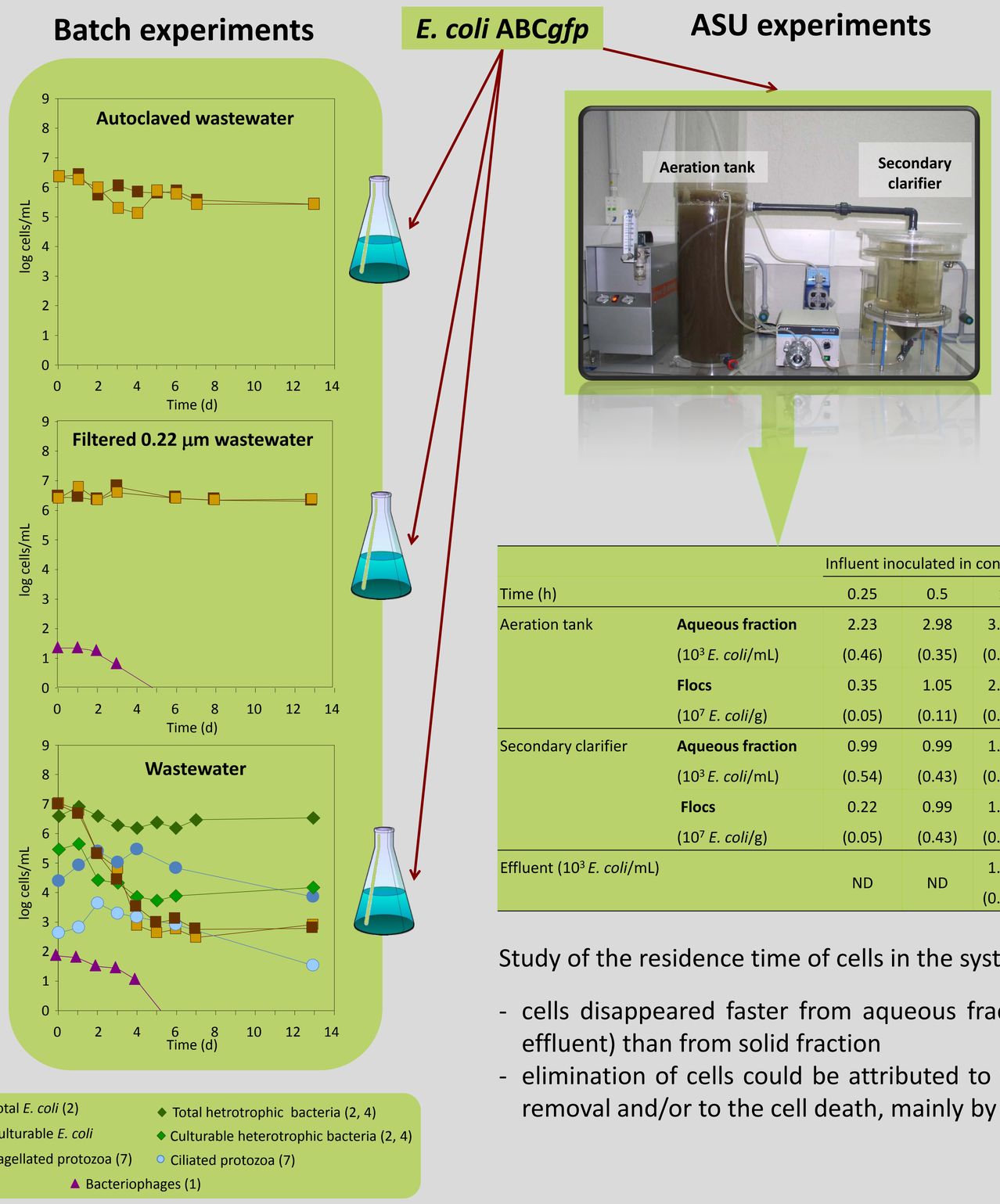
To take an approach to the main mechanisms involved in the reduction of pathogenic microorganisms during activated sludge wastewater treatment.

Results and Discussion

In **absence of microbial population**, the exposure of tagged *E. coli* to wastewater did not affect the culturability, activity and integrity of the cells. Entry into the viable but nonculturable state (3) could not be induced during wastewater treatment.

Bacteriophages did not affect the survival of tagged *E. coli* in wastewater.

Complex interactions between microbial populations and *E. coli* occur in presence of wastewater microbiota. Wastewater bacteria maintained their population density, while *E. coli* ABC*gfp*, behaving as predation non-escaping prey, was predated (2). Predation by **protozoa** is an important removal mechanism of bacteria in activated sludge.



60-70% of introduced *E. coli* cells remained in the ASU system, and a very few cells were recovered in effluents, so **predation** could be responsible of the removal of resting fraction.

Almost 95% of remaining *E. coli* cells was present in flocs and sludge; what points out:

- the importance of **adhesion** to solid fractions to eliminate cells
- the protective role of adhesion to flocs and sludge to face up to predation by protozoa.

		Influent inoculated in continuous with *gfp*-tagged *E. coli*						Influent non-inoculated			
Time (h)		0.25	0.5	1	2	3	4	2	4	24	48
Aeration tank	**Aqueous fraction**	2.23	2.98	3.97	17.4	10.1	15.8	1.79	1.59	ND	ND
	(10^3 *E. coli*/mL)	(0.46)	(0.35)	(0.56)	(1.07)	(1.11)	(0.98)	(0.45)	(0.38)		
	Flocs	0.35	1.05	2.92	24.8	25.7	47.3	2.69	3.38	1.06	0.12
	(10^7 *E. coli*/g)	(0.05)	(0.11)	(0.21)	(1.35)	(1.48)	(2.35)	(0.43)	(0.31)	(0.85)	(0.02)
Secondary clarifier	**Aqueous fraction**	0.99	0.99	1.98	21.8	17.8	18.6	4.47	1.69	0.33	ND
	(10^3 *E. coli*/mL)	(0.54)	(0.43)	(0.75)	(1.78)	(1.12)	(0.98)	(0.45)	(0.65)	(0.05)	
	Flocs	0.22	0.99	1.10	33.4	39.8	42.0	2.66	4.42	0.66	0.05
	(10^7 *E. coli*/g)	(0.05)	(0.43)	(0.65)	(5.89)	(3.72)	(3.72)	(0.41)	(0.54)	(0.43)	(0.01)
Effluent (10^3 *E. coli*/mL)		ND	ND	1.06	4.10	5.23	5.10	1.49	1.88	0.33	ND
				(0.32)	(0.43)	(0.44)	(0.43)	(0.32)	(0.55)	(0.21)	

Study of the residence time of cells in the system by stopping *E. coli* inoculation:

- cells disappeared faster from aqueous fractions (aeration tank, secondary clarifier and effluent) than from solid fraction
- elimination of cells could be attributed to the washing with new influent, to the sludge removal and/or to the cell death, mainly by predation.

Conclusions

Due to the quantitative importance of cell adhesion to sludge with respect to cell removal via predation (real elimination), the recycling of sludge can suppose a sanitary and ecological risk.

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