The fate of *Cryptosporidium* spp. and other pathogens in secondary sewage treatment processes

Fate of *Cryptosporidium parvum* and *Cryptosporidium hominis* and *Giardia duodenalis* cysts during secondary wastewater treatments. *Parasitol. Res.,* April, 2009

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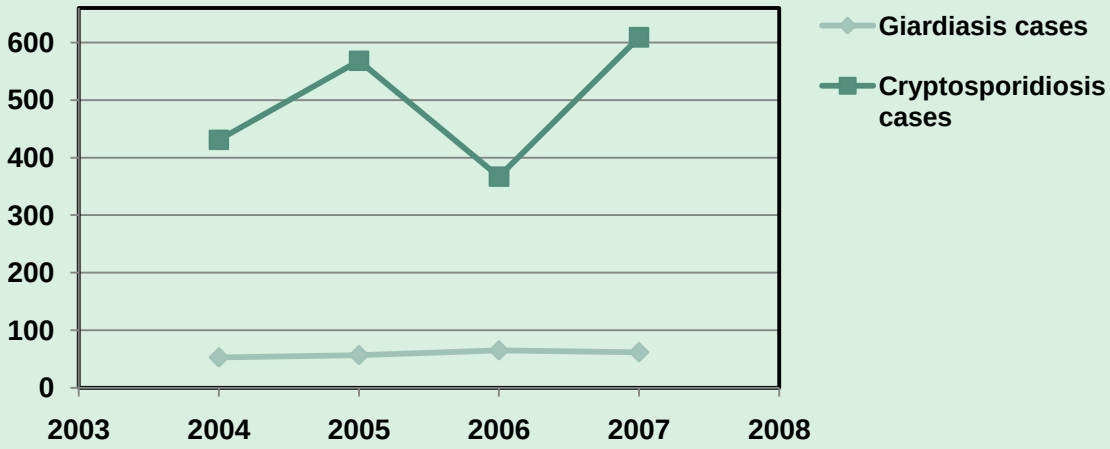
Location: Hodson Bay Hotel, Athlone

Introduction

In 2007, Cryptosporidiosis cause the second highest gastroenteritis in Ireland (16 outbreaks and 602 cases)[1].



In 2007, 75% of sewage treatment plants receive secondary treatment in Ireland[2].

Twenty sewage treatment plants in Co. Sligo and 67.8% are equipped with secondary treatment infrastructures.

[1]2007 Annual report. Health Protection Surveillance Centre. [2] Irish EPA

Introduction

Yellow: Plants with poor effluent quality in 2007
Blue: Plants with good effluent quality

Introduction

To investigate:

(1) Presence of human virulent pathogens in sewage samples (Influent, Activated sludge, and end products- **final effluent/ biosolids**)

C. parvum and *C. hominis* oocysts;

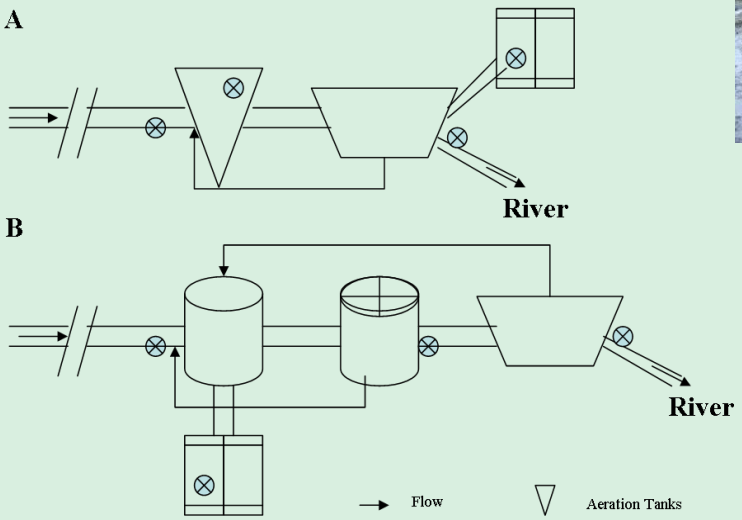
Giardia duodenalis cysts;

microsporidian spores (*Enterocytozoon bieneusi*, *Encephalitozoon hellem*, *E. intestinalis*)

(2) Pathogen removal efficiencies of four sewage treatment plants in Co. Sligo.

(3) Are there any oocysts, cysts, and spores discharged to the local environment?

Sewage treatment process

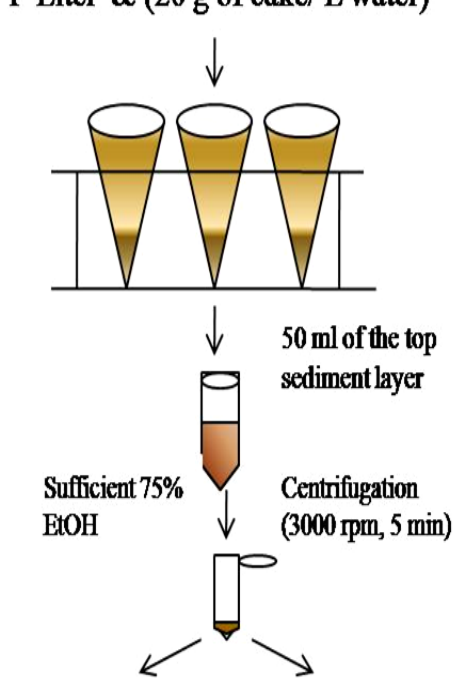


Sewage treatment plants in study

WwTPs	Served PE	Preliminary and primary process	Secondary process	Resulting sludge*
Plant A	1,950	Grit removal and screening	Oxidation ditch	4.12 Tonnes with 0.75% dried solids
Plant B	1,100	None	Activated sludge, extended aeration	0.76 Tonnes with 0.75% dried solids
Plant C	2,500	Grit removal, screening, and sedimentation	Activated sludge, extended aeration	1.82 Tonnes with 2.50 % dried solids
Plant D	2,150	Grit removal, screening, and primary sedimentation	Percolating filtration	8 Tonnes with 0.75% dried solids

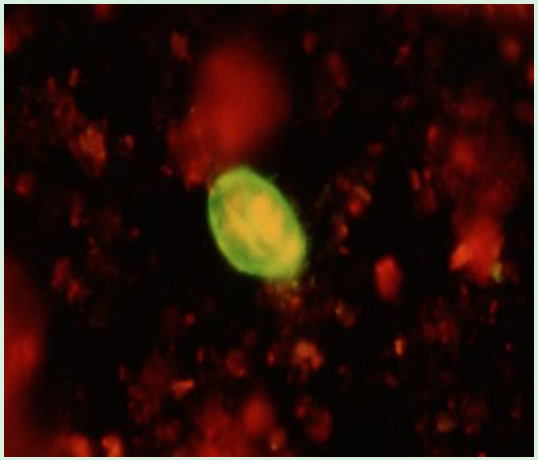
*Yearly produced volume obtained from local authority

Materials and methods

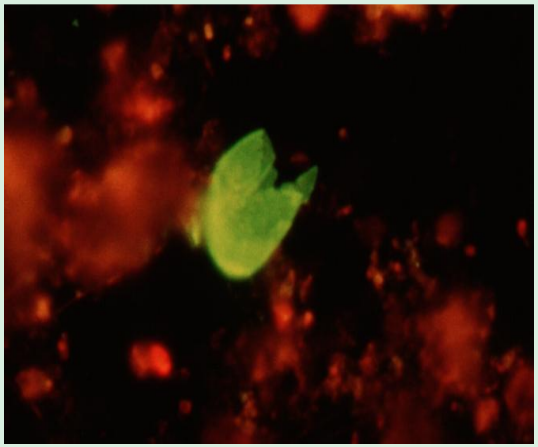


Cryto/Giardia:
1. Multiplex combined FISH
2. Immunofluorescent Antibody (*Merifluor G/C kit*)

Microsporidia spp.:
Multiplex combined FISH
E. bien, E. cun, E. hel, and E. Int



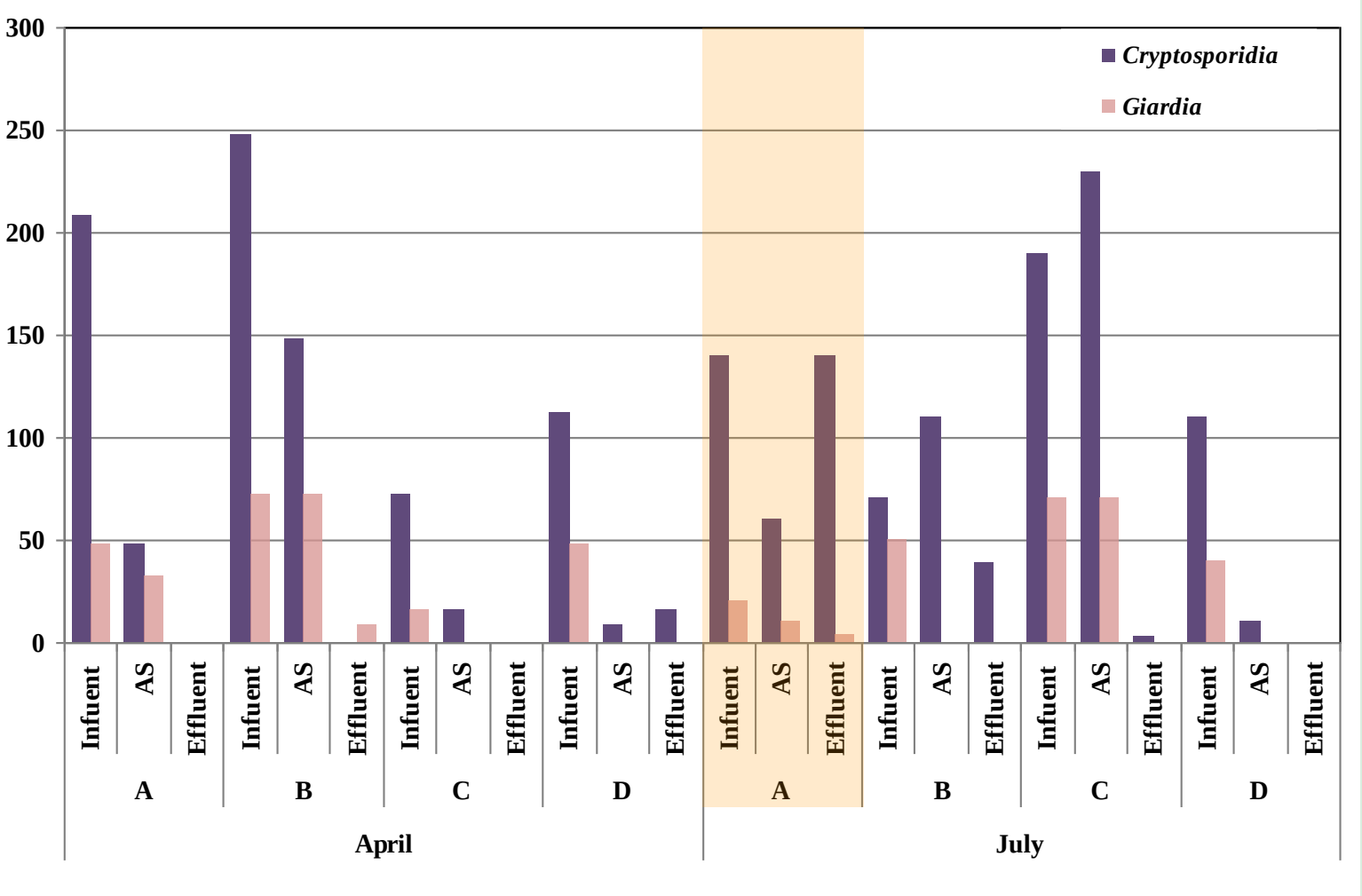
A. Viable cyst of *Giardia duodenalis*



B. Non-viable cyst of *Giardia duodenalis*

Results-Wastewater

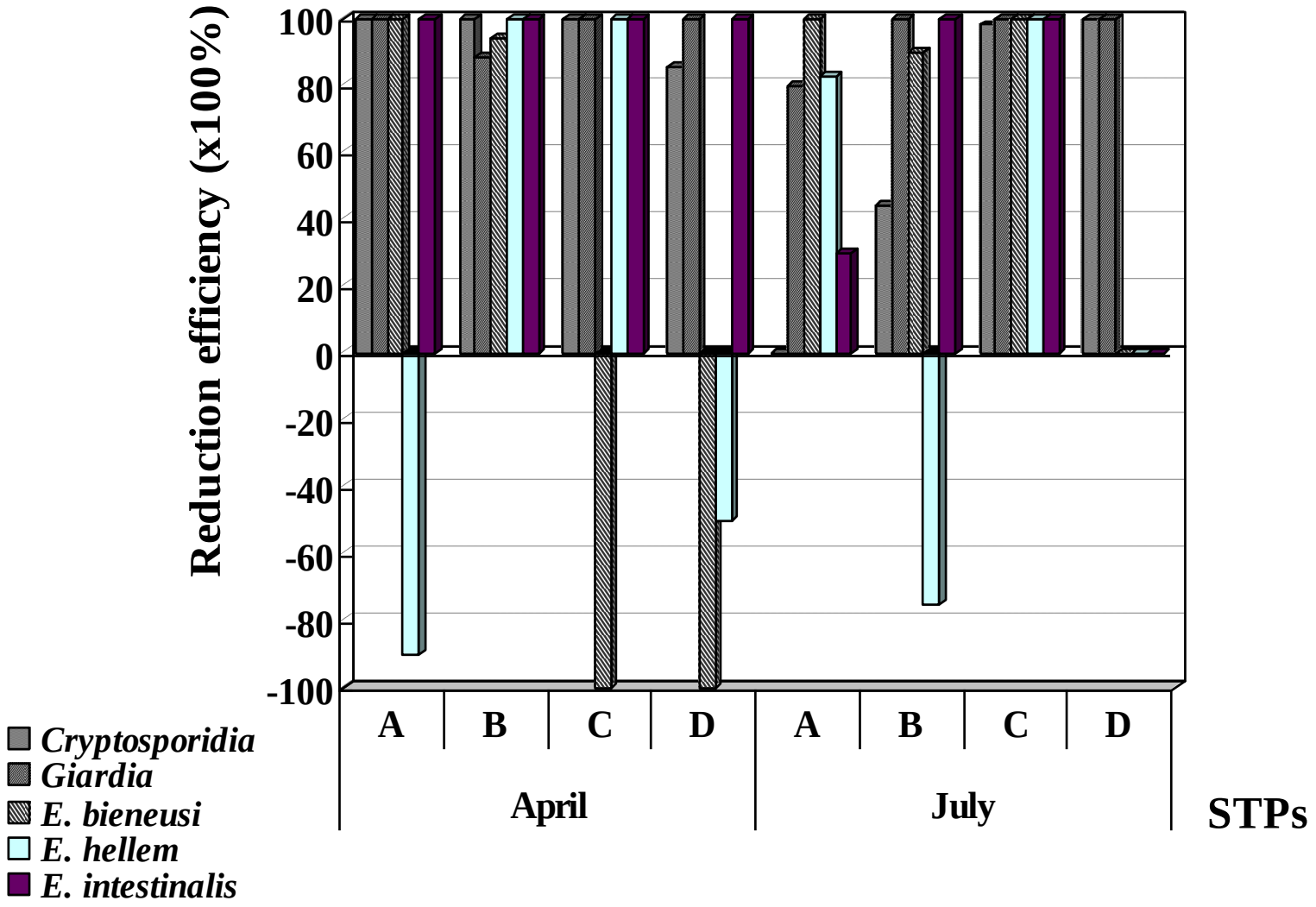
Medium value of oocysts and cysts in April and July samples



Results-Wastewater/Microsporidian spores

			E. bieneusi		*E. hellem*		*E. intestinalis*	
Sampling	Plants	Treatment	Median	Quartiles	Median	Quartiles	Median	Quartiles
April	A	Influent	12	(1; 16)	2	(1; 7)	12	(8; 12)
		AcSS	2	(0; 11)	3	(2; 6)	0	(0; 0)
		Effluent	0	(0; 0)	20	(13; 27)	0	(0; 0)
	B	Influent	46	(37; 89)	8	(7; 9)	22	(12; 31)
		AcSS	22	(12; 32)	0	(0; 0)	3	(3; 3)
		Effluent	4	(2; 4)	0	(0; 0)	0	(0; 0)
	C	Influent	0	(0; 0)	5	(5; 6)	3	(1; 7)
		AcSS	0	(0; 0)	0	(0; 0)	0	(0; 0)
		Effluent	6	(3; 9)	0	(0; 0)	0	(0; 0)
	D	Influent	0	(0; 0)	9	(6; 9)	1	(1; 3)
		AcSS	0	(0; 0)	0	(0; 0)	0	(0; 0)
		Effluent	13	(10; 15)	15	(14; 19)	0	(0; 0)
July	A	Influent	470	(400; 620)	180	(140; 400)	280	(250; 300)
		AcSS	120	(100; 130)	540	(480; 1,090)	390	(310; 500)
		Effluent	0	(0; 0)	40	(30; 50)	220	(100; 260)
	B	Influent	180	(150; 190)	30	(30; 40)	70	(50; 80)
		AcSS	120	(120; 140)	10	(0; 10)	60	(40; 70)
		Effluent	20	(10; 20)	130	(100; 180)	0	(0; 0)
	C	Influent	200	(130; 200)	130	(90; 230)	30	(20; 70)
		AcSS	120	(120; 130)	80	(80; 100)	10	(0; 40)
		Effluent	0	(0; 0)	0	(0; 0)	0	(0; 0)
	D	Influent	0	(0; 0)	0	(0; 0)	0	(0; 0)
		AcSS	0	(0; 1)	0	(0; 0)	0	(0; 0)
		Effluent	0	(0; 0)	0	(0; 0)	0	(0; 0)

Results- Removal efficiency



Results-Biosolids

Medium value of oocysts, cysts, spores in biosolids (/Kg)

Month	Plants	*Cryptosporidia*	*Giardia*	*E. bieneusi*	*E. Hellem*	*E. Intestinalis*
April	A	4,400	1,220	1,550	500	600
	B	6,900	2,400	3,350	350	600
	C	400	0	450	400	0
	D	8,800	4,800	3,950	500	0
July	A	46,000	12,500	3,500	0	1,500
	B	31,500	6,000	19,000	9,500	16,000
	C	4,500	1,000	1,000	0	0
	D	47,000	8,500	6,000	32,000	11,000

Conclusions

- *Cryptosporidium* oocysts, *Giardia* cysts and microsporidian spores are present in this human population
- **Wastewater**: Removal efficacy

  Cryptosporidium oocysts (0~ 100%)

  Giardia cysts (88~100%)

  Microsporidian spores (-100~ 100%)
- **Biosolids**: Plant D contained the highest concentration of *Cryptosporidium* oocysts (8,800~ 47,000 oocysts/Kg), *Giardia* cysts (4,800~ 8,500 cysts/Kg), and microsporidian spores (in total: 49,000 spores/Kg)

Conclusions

- *Cryptosporidium* oocysts and *Giardia* cysts were found in higher abundance in April than in July.
- However, July samples had significant higher amounts of microsporidian spores than in April.
- Surplus microsporidian spores in final effluents
  => contribution from the visiting wildlife (birds).
- Effluents and biosolids (most important) contain viable pathogens, with subsequent risks of cryptosporidiosis and giardiasis (microsporidiosis for HIV patients) for public health.

Acknowledgement

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