Fate of Pathogens in tomato plants and soil irrigated with secondary treated wastewater

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Background

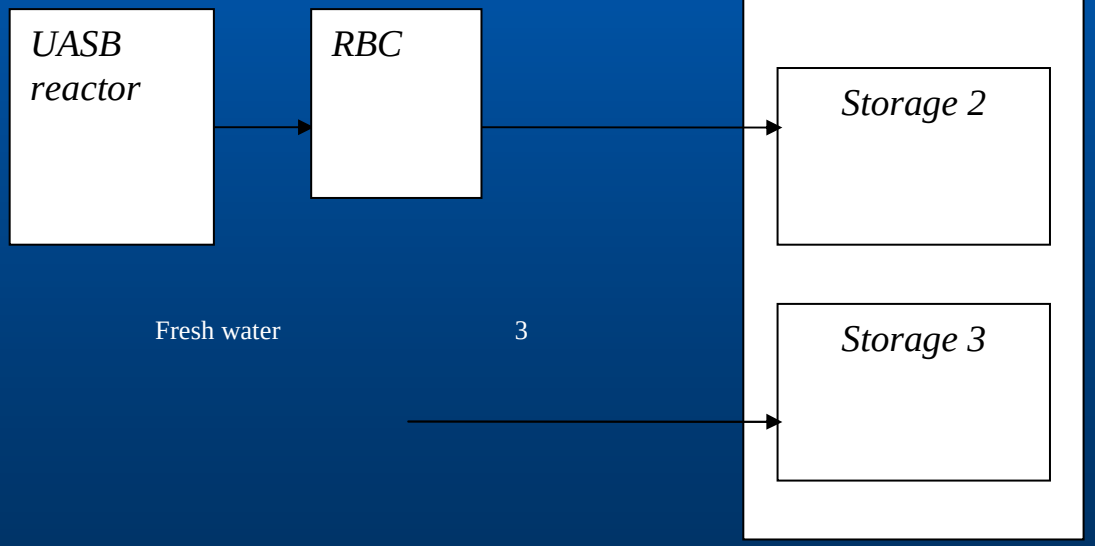
- Production of a standard effluent

The same quality of crops can be obtained with lower quality water if proper irrigation techniques are used.

- Combining risk assessment and risk management

- Jordanian standards

Effluent of the treatment plant (without chlorination) 1

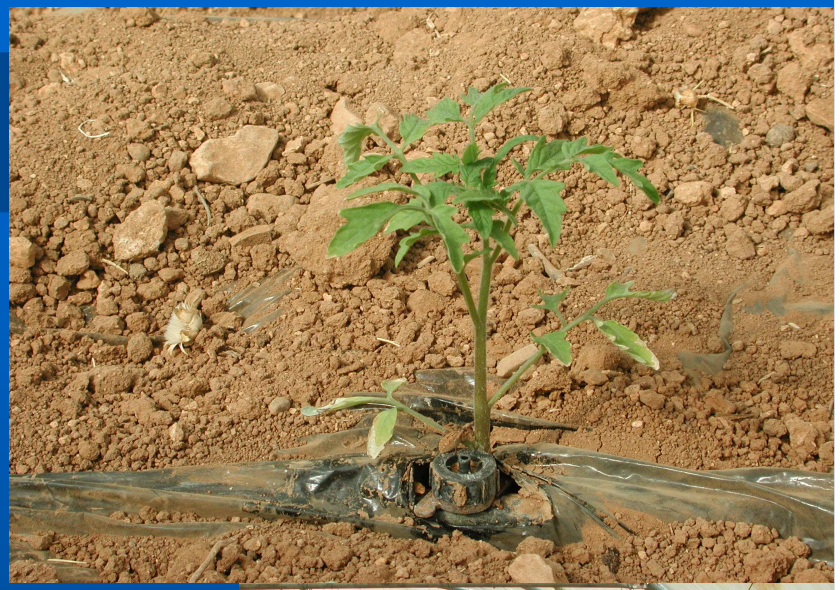


Biological Indicators measured for the treatments

Parameter	WWTP $\times 10^5$	UASB-RBC $\times 10^5$	FW
Tot. Coliform (MPN/100ml)	4.8	68.69	<1
E.Coli (MPV/100ml)	1.5	31.77	<1
Enterococous(MPN/ 100ml)	0.02	0.008	

Salmonella was not detected in all collected water samples

According to WHO guidelines (1989), treated WW with this quality should not be used for unrestricted irrigation



- 500 m^2 greenhouse
- Pressurized drip irrigation system
- Water requirements were calculated based on pan measurements
- Blocks were randomly distributed
- Area subjected to irrigation water was covered with mulch (a common practice in the Jordan Valley)

Soil samples were collected after 5 and 10 days of the last irrigation respectively. Samples were taken at four depths: 0-15 cm, 15-30 cm, 30-45 cm and 45-60 cm. Water samples were collected prior to each irrigation while leaves and fruits of tomato plants were collected at the end of the experiment.

Biological indicators in leaves and fruits of tomato

	T.Coliform (MPN/g dry plant)		
	FW	WWTP	UASB-RBC
Leaves	<1	<1	<1
Fruits	<1	<1 (71.57)	<1
	E.Coli (MPN/g dry plant)		
Leaves	<1	<1	<1
Fruits	<1	<1	<1
	Enterococous (MPN/g dry plant)		
Leaves	<1	<1 (24.29)	<1 (2.3×10^3)
Fruits	<1	<1	<1 (20.45)

Produce washing would result in 1 log pathogens reduction according to WHO, 2006

The results obtained show that when irrigation techniques and agricultural practices are taken into account, health risks are minimized at lower treatment costs.

Indicator pathogens in soil

	5 days after the last irrigation			10 days after last irrigation		
	Total Coliform /g dry soil			Total Coliform (MPN/ g dry soil)		
Depth	FW	WWTP	UASB-RBC	FW	WWTP	UASB-RBC
0-15	339	8.95	70.45	15.48	19.23	<1
15-30	1.19×10^{3}	4.36	19.60	<1	<1	<1
30-45	5.67	1.98	199	<1	2.74	<1
45-60	38.90	133	33.38	<1	3.82	<1
	E.coli (MPN/g dry soil)			E.coli (MPN/g dry soil)		
Depth	FW	WWTP	UASB-RBC	FW	WWTP	UASB-RBC
0-15	<1	1.499	24.08	<1	<1	<1
15-30	3.13	1.195	6.92	<1	<1	<1
30-45	<1	<1	<1	<1	<1	<1
45-60	6.69	<1	2.74	<1	<1	<1
	Enterococcus (MPN/g soil)			Enterococcus (MPN/g dry soil)		
Depth	FW	WWTP	UASB-RBC	FW	WWTP	UASB-RBC
0-15	1.28×10^{3}	96.74	891	22.39	14.93	8.79
15-30	513	42.53	715	14.43	13.44	23.36
30-45	57.98	40.04	36.52	1.17	20.02	7.24
45-60	22.96	43.11	1.31×10^{3}	0	7.04	8.11

- The count of all pathogens decreased with time and soil dryness as shown after 10 days of irrigation cessation compared with 5 days. Short survival time was noticed for *E.coli.*
- Ruffete *et al*., (2006) indicated that soils may originally contain background total coliforms.
- Regrowth of indicator pathogens in soil was reported by Gibbs *et al*., (1997) and high humidity was found to be among factors that help in growth of enteric bacteria (Entry *et al*., 2000; Rufete *et al*., 2006)

Open for discussion…

Protection of public health can not be achieved solely at the treatment plant as regrowth of pathogens has been reported especially when chlorine is used for disinfection (Gantzer *et al*., 2001; Tchobanoglous *et al*., 2003)

Health protection can be achieved by using a ‘multiple barriers’ approach that interrupts the flow of pathogens to human.

Open for discussion…

With respect to the quality of surface water used for unrestricted irrigation, it is common to find lenient standards compared with those implemented for irrigation using reclaimed wastewater (Carr *et al*., 2004).

A general conclusion

With respect to the measured indicator pathogens, the obtained results suggest that disinfection of reclaimed wastewater may not be necessary when proper agricultural practices are applied downstream of the treatment plant.

Acknowledgement

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