HEALTH RISK FROM POTABLE AND NON-POTABLE USES OF ROOF-HARVESTED RAINWATER USING QUANTITATIVE MICROBIAL RISK ASSESSMENT

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Summary

QMRA analysis was used to quantify the risk of infection associated with the exposure to pathogens from potable and non-potable uses of roof-harvested rainwater. The risk infection from *Salmonella* spp.., *Giardia lamblia* and *L. pneumophila* associated with the showering and garden hosing was well below the threshold value of one extra infection per 10,000 persons/year in urban SEQ. However, the risk of infection from ingestion of *Salmonella* spp., and *G. lamblia* via drinking exceeds the threshold value and indicates that if untreated rainwater were ingested by drinking then the gastrointestinal diseases of Salmonellosis and Giardiasis is expected to range from 5-28 and 10-64 cases/ 10,000 persons/year , respectively. Since the health risk seems higher than that expected from the reported incidences of gastroenteritis, it seem prudent to disinfect rainwater for potable use.

Objective

Apply QMRA analysis in order to estimate the risk of infection from exposure to pathogens found in roof-harvested rainwater.

Methodology

1. In all, 214 rainwater samples were collected from 82 tanks in urban SEQ in Australia

2. qPCR methods were used to quantify *Salmonella* spp. and *G. lamblia* in water samples

3. QMRA is a four-step process for estimating the human health risk associated with defined scenarios from exposure to pathogens. The four steps are (I) Hazard identification (II) exposure assessment (III) dose-response assessment, and (IV) risk characterization.

4. Hazard identification – Pathogens were identified in rainwater tanks

5. Exposure assessment – Pathogens numbers and the volume ingested/inhaled by a person were estimated and the risk scenarios were estimated.

6. Dose response assessment – The relationship between administered dose and the probability of infection in the exposed population. For *Salmonella* spp. a Beta-Poisson dose and for *G. lamblia* an exponential dose-response model was used.

7. Risk characterisation – exposure and dose-response assessment are combined to estimate the probability of infection (expressed as likely numbers of infections/10,000 persons/year.

Results

1. Numbers of pathogens in water sample from roof-harvested rainwater in SEQ

Pathogens	Geometric mean of genomic copies/L of water	Geometric mean of cells and cysts/L of water [a]	Geometric mean of viable and infective cells and cysts/L of water [b]
Salmonella spp.	$1.5 \quad 10^{2}$	$1.5 \quad 10^{2}$	$3.8 \quad 10^{1}$
G. lamblia	$2.2 \quad 10^{1}$	$1.4 \quad 10^{0}$	$3.5 \quad 10^{-1}$

[a] Genomic copies were converted to cell counts and cysts; [b] Assumes 25% of the cells are viable and infective.

2. Exposure pathway, ingested/inhaled volumes and calculated ingested/inhaled pathogen dose for individuals exposed to tank water containing pathogens

Pathogens exposure and risk scenarios	Volume per day or event	Geometric mean of dose
Salmonella spp.		
Liquid ingestion via drinking	1000 ml	$3.8 \quad 10^{1}$
Liquid ingestion via hosing	1 ml	$3.8 \quad 10^{-2}$
G. lamblia		
Liquid ingestion via drinking	1000 ml	$3.5 \quad 10^{-1}$
Liquid ingestion via hosing	1 ml	$3.5 \quad 10^{-4}$

3. For liquid ingestion via drinking, $3.8 \quad 10^{1}$ *Salmonella* cells and $3.5 \quad 10^{-1}$ *G. lamblia* cysts may be ingested.

4. Infection risks for individuals exposed to contaminated tank water for two risk scenarios

Pathogens exposure and risk scenarios	Geometric mean of infection risk/ 10,000 exposed people with rainwater tanks from single event	% of SEQ population exposed to pathogens	Geometric mean of infection risk/ 10,000 people in SEQ from single event	No of events per year	Geometric mean of infection risk/ year (No. per 10,000 people in SEQ)
Salmonella spp.					
Liquid ingestion via drinking	$4.1 \quad 10^{1}$	0.77	$3.2 \quad 10^{-1}$	36.5	$1.2 \quad 10^{1}$
Liquid ingestion via hosing	$4.2 \quad 10^{-2}$	3.66	$3.2 \quad 10^{-4}$	10.4	$3.3 \quad 10^{-3}$
G. lamblia					
Liquid ingestion via drinking	$6.9 \quad 10^{1}$	1.01	$6.9 \quad 10^{-1}$	36.5	$2.5 \quad 10^{1}$
Liquid ingestion via hosing	$6.9 \quad 10^{-2}$	4.75	$6.9 \quad 10^{-4}$	10.4	$7.2 \quad 10^{-3}$

5. The risk of infection from ingestion *Salmonella* spp. and *G. lamblia* via drinking far exceeds the threshold value of one extra infection/10,000 persons/ year, and indicates that if untreated rainwater were ingested by drinking, then the gastrointestinal diseases of Salmonellosis and Giardiasis is expected to be high with infection incidence ranging from 5-28 (Salmonellosis) and 10-64 (Giardiasis) cases/10,000 urban SEQ

Conclusions

Current estimates of health risk suggests that it would be prudent to disinfect roof-harvested rainwater such as the installation of a UV disinfection unit, boiling or other forms of disinfectants before using the water for potable uses, especially drinking. Maintenance of good roof and gutter hygiene, and elimination of overhanging tree branches and other structures where possible to prevent the congregation of animals is also recommended. Consideration should be given to include Giardiasis to the notifiable disease list in Queensland, given that Giardia was found in rainwater tank samples.