

# Pathogen and indicator inactivation in source-separated human urine heated by the sun

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## ABSTRACT

Source-separation of urine enables energy-efficient recycling of large quantities of high quality plant nutrients from the wastewater system to food production. To manage the risk of diseases transmission the urine should be sanitised, which is commonly done by storage. The sanitisation of urine at three ambient exposures, resulting in fluctuating storage temperatures, was studied in 10 L plastic jerry cans in Kampala, Uganda. Follow-up studies using similar temperature cycles were performed under laboratory conditions. Daily mean mid-point temperature in jerry cans in full sun, adjacent to a wall and indoors was 24, 24 and 22 °C (amplitude 7.5, 4.7 and 1.2 °C), respectively. In urine stored at full sun (total ammonia nitrogen  $4 \pm 1.5$  g L<sup>-1</sup>, pH 9) *Escherichia coli*, *Salmonella* and *Enterococcus* spp. (initially 10<sup>5</sup>-10<sup>6</sup> cfu mL<sup>-1</sup>) were not detected (<10<sup>1</sup> cfu mL<sup>-1</sup>) after 11 h, 14 h and 50 d, respectively. No viable *Ascaris suum* eggs were found after 40 d. The t<sub>90</sub> for enterobacteria phage MS2, coliphage  $\phi$ x 174 and *Salmonella typhimurium* phage 28B in sun-exposed cans was 8.2, 37 and 55 d respectively. Fluctuating temperatures in combination with ammonia gave faster inactivation of bacteria and *Ascaris suum* eggs than the same constant mean temperature.

**Keywords:** inactivation, pathogen, sanitisation, source-separation, temperature, urine