Blue Diversion AUTARKY
Sanitation off the grid

FSM4

Inactivation Of Ascaris In Urine By Drying In Calcium Hydroxide

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eawag aquatic research
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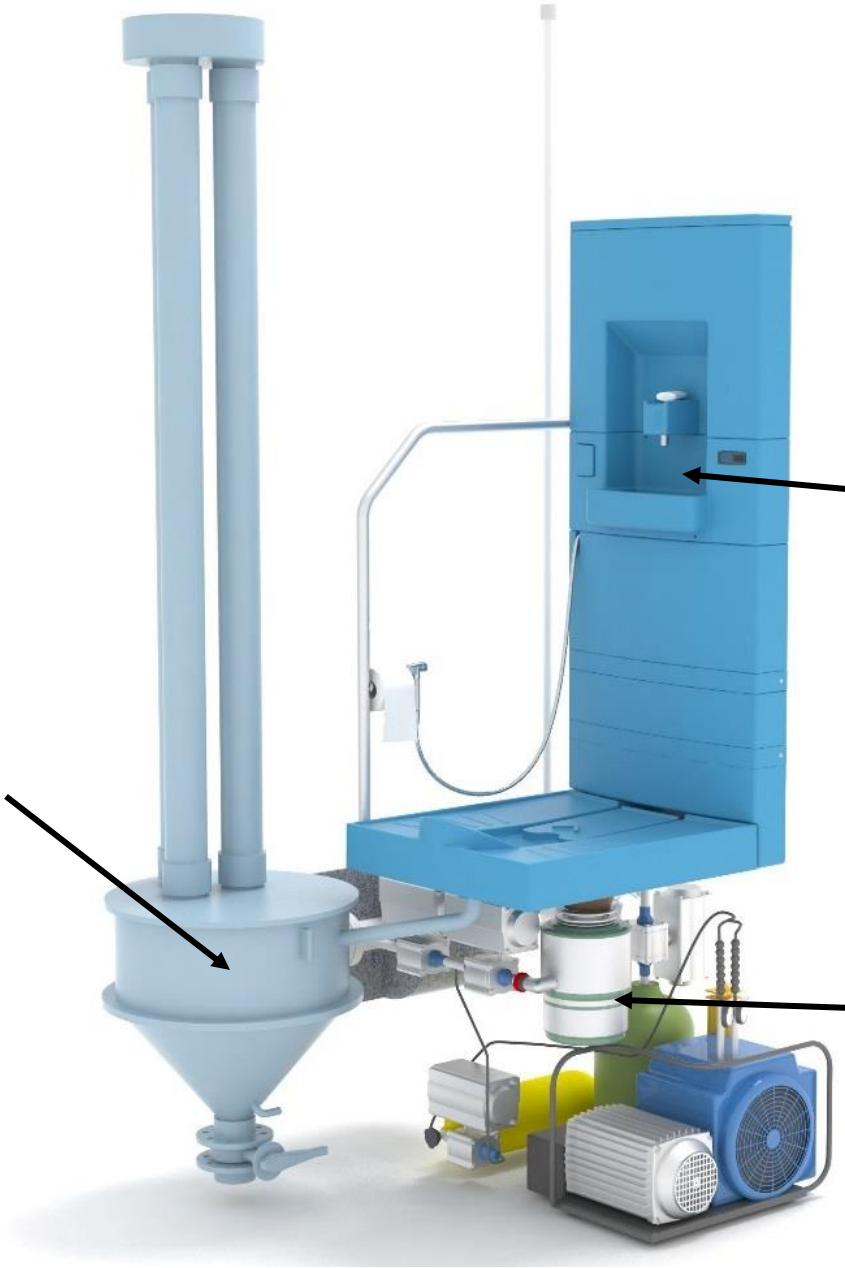
EOOS



Handwashing
water treated by gravity feed membrane and electrolysis

Urine stabilized, by calcium hydroxide, and water removed, by evaporation

Feces treated by hydrothermal oxidation

Urine treatment

1. Stabilization of fresh urine

Addition of hydrated lime $Ca(OH)_2$ preserves urea

2. Evaporation of stabilized urine

Excess water is evaporated.

Randall, D. G., et al. (2016). Water Research **95**: 361-369.

Senecal, J. and Vinnerås, B. (2017). Science of The Total Environment (In press)

Hygienization effect?

Hygiene assessment

Pathogen Indicators

- Bacteria
  - known that they do not survive at pH > 11 (Nyberg et al., 2011)

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- Helminths
  - Ascaris suum eggs = persistent & resilient

Hygiene assessment

Experimental set up

1. Stabilization

- Mixed 10 g $Ca(OH)_2$ L^{-1} urine for 10 min
  - Allowed to stabilize for 3 h
  - Final pH =12.5
- After stabilization, added faeces inoculated with Ascaris
  - Blended 20 000 eggs g^{-1} faeces
  - ~13 000 eggs L^{-1} urine

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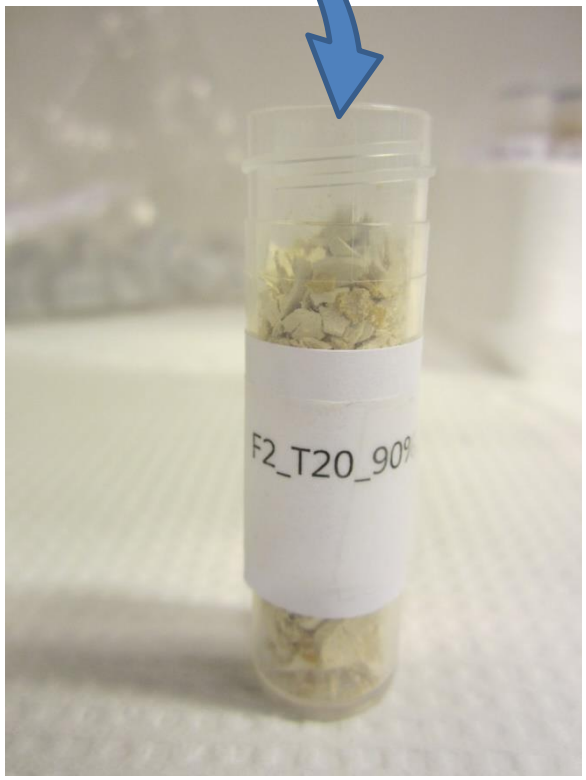
2. Evaporation

- Three total solids
  - No dying (<10% TS)
  - Partially dried (20-40% TS)
  - Dried (85% TS)

Hygiene assessment

Experimental set up

Dried urine transferred into sealed containers



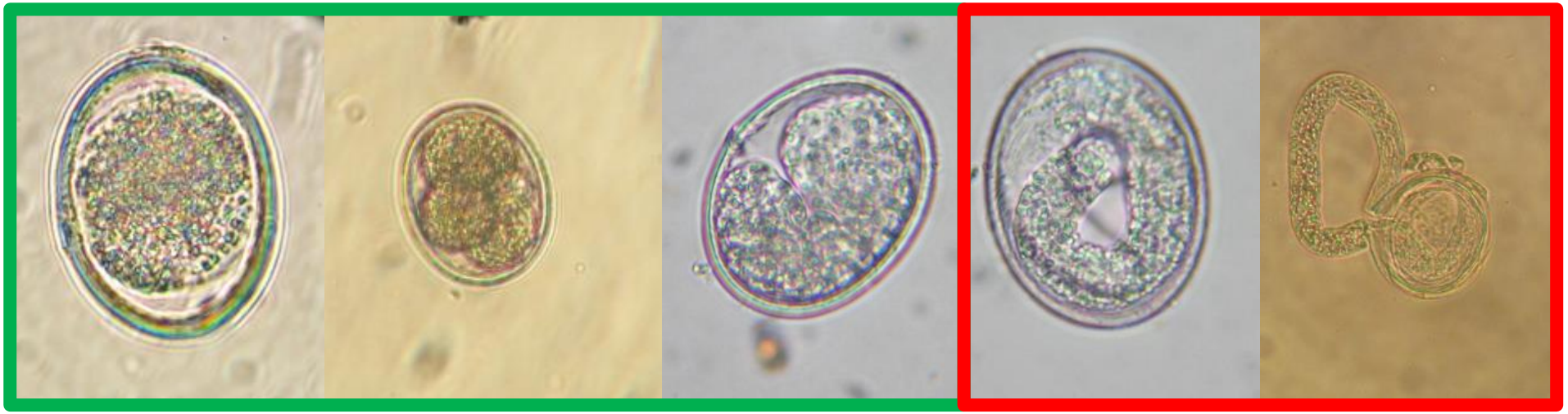
Incubated at two temperatures
20 and 35°C

Hygiene assessment

Development stages and viability of Ascaris after 28 days of incubation

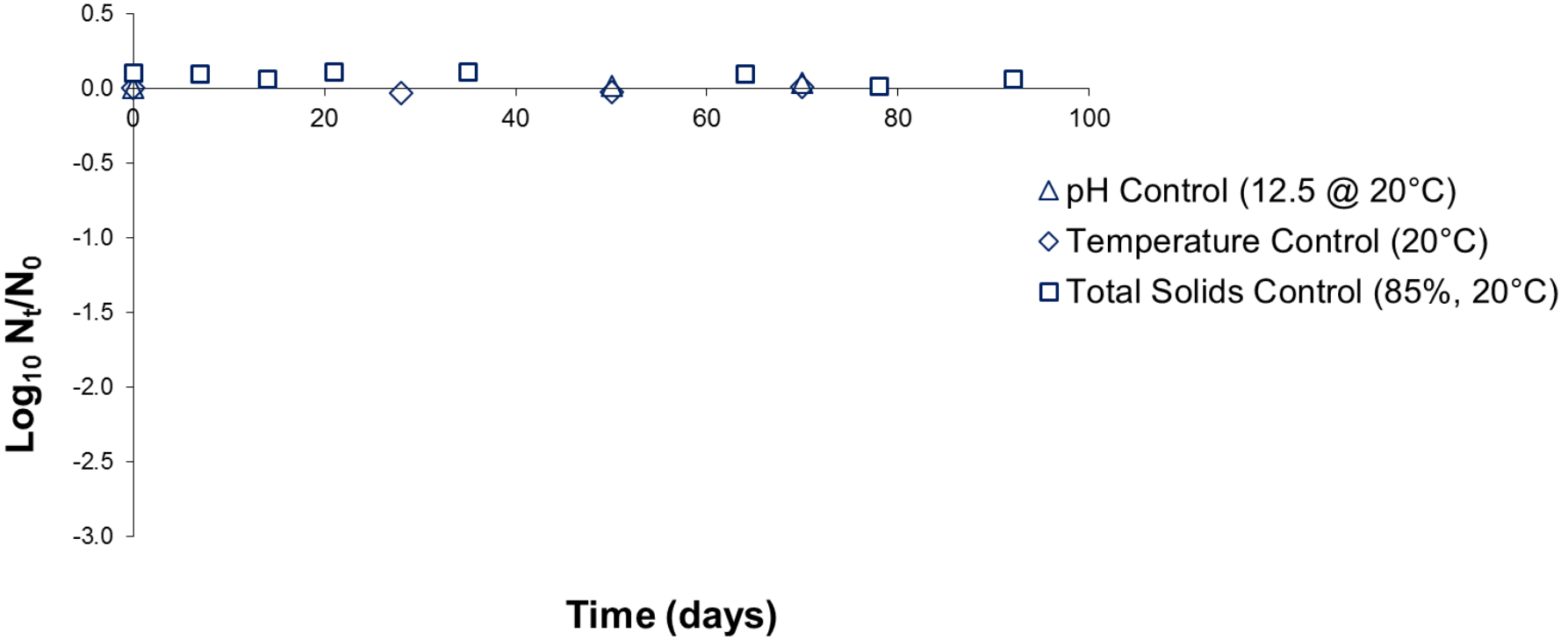
Non-viable

Viable



Hygiene assessment

Results for inactivation of Ascaris in treated dried-urine



Log_{10} inactivation of ascaris egg viability over time at 20 and 35°C in urine-$Ca(OH)_2$ suspension dried to a TS of 85% (○) and controls for pH 12.5 (Δ) and TS 90% (■) and temperature (◊).

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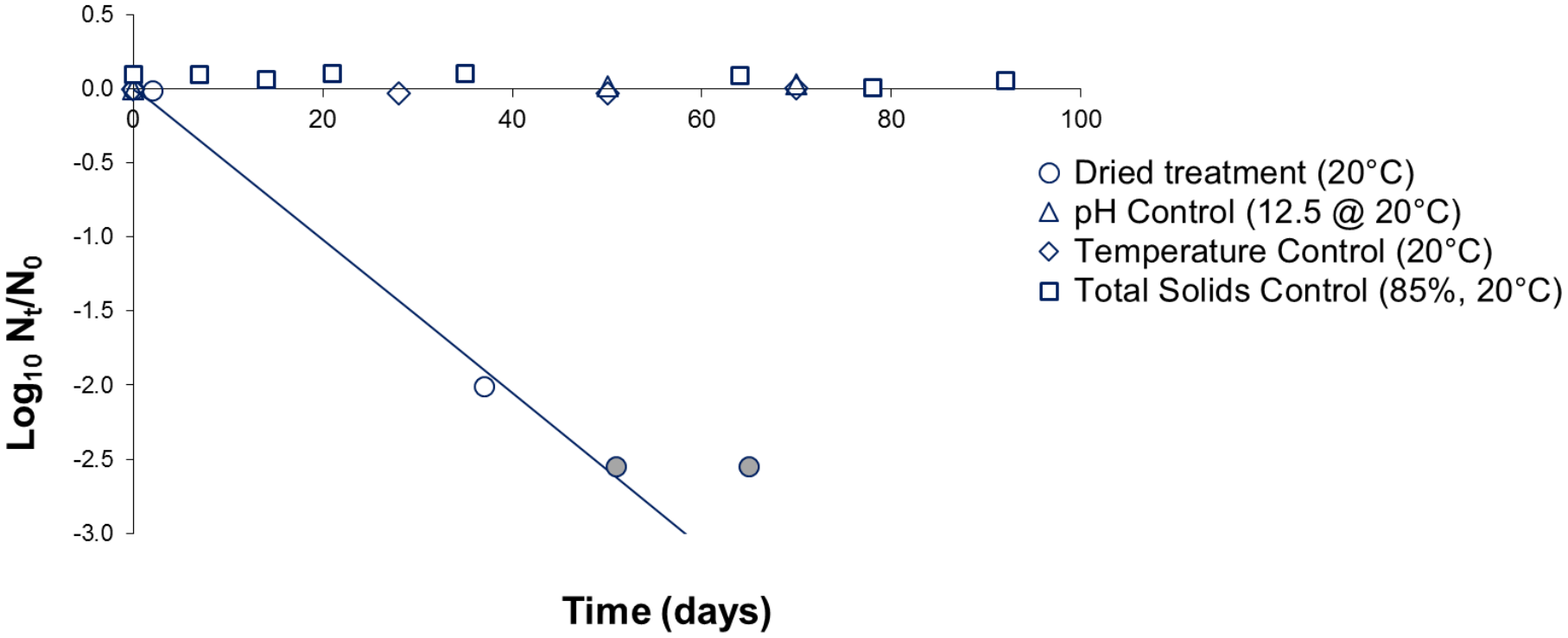

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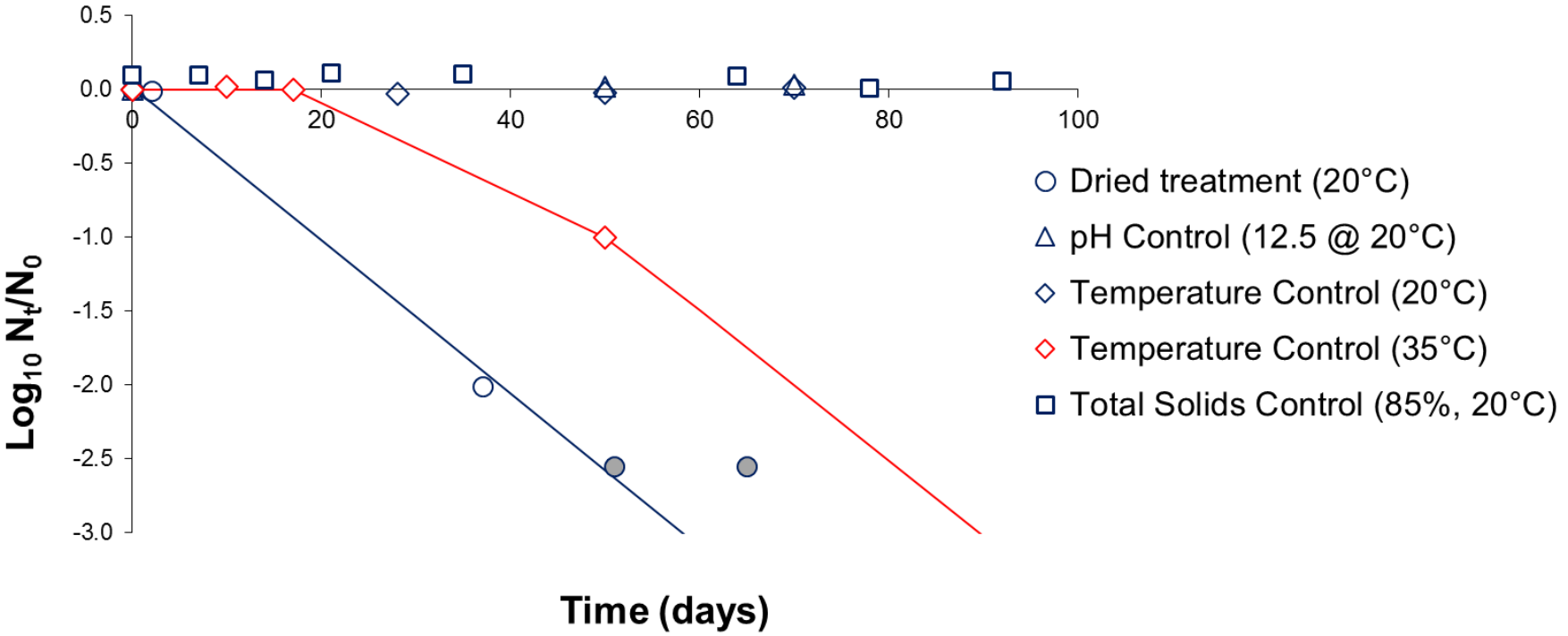

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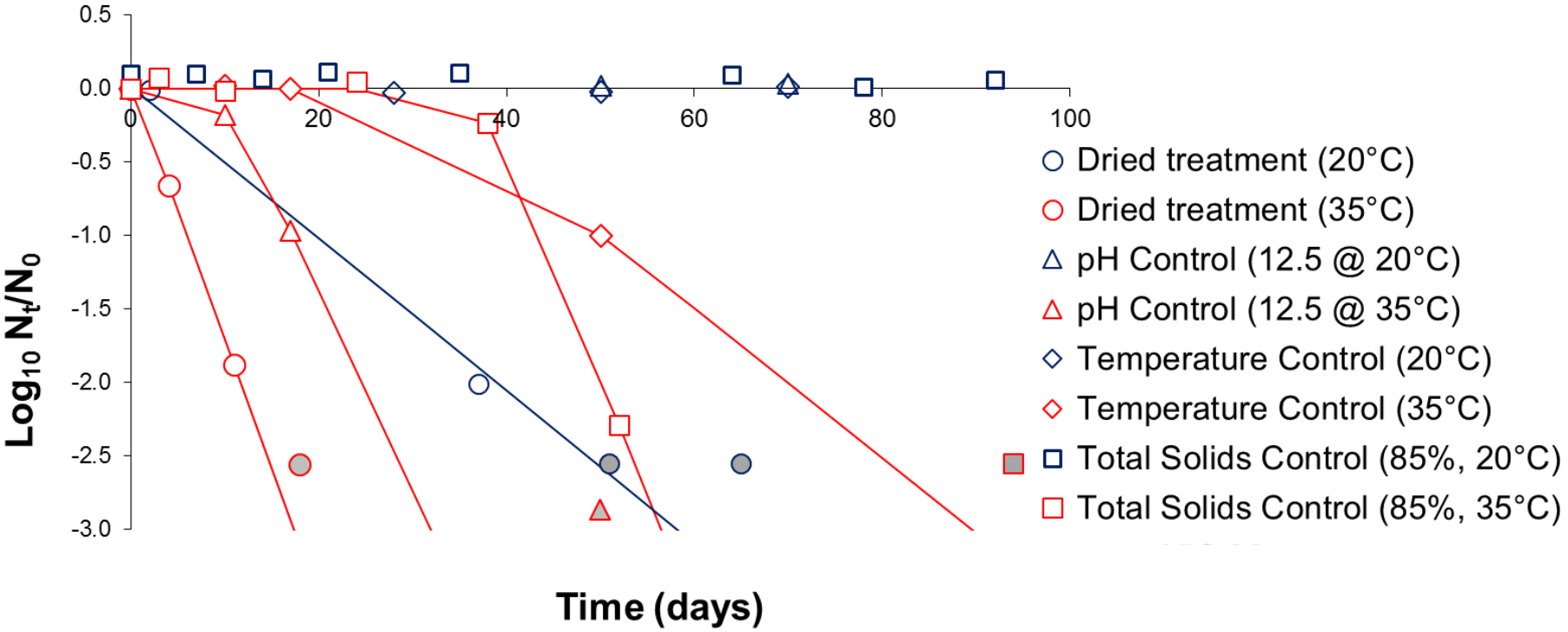

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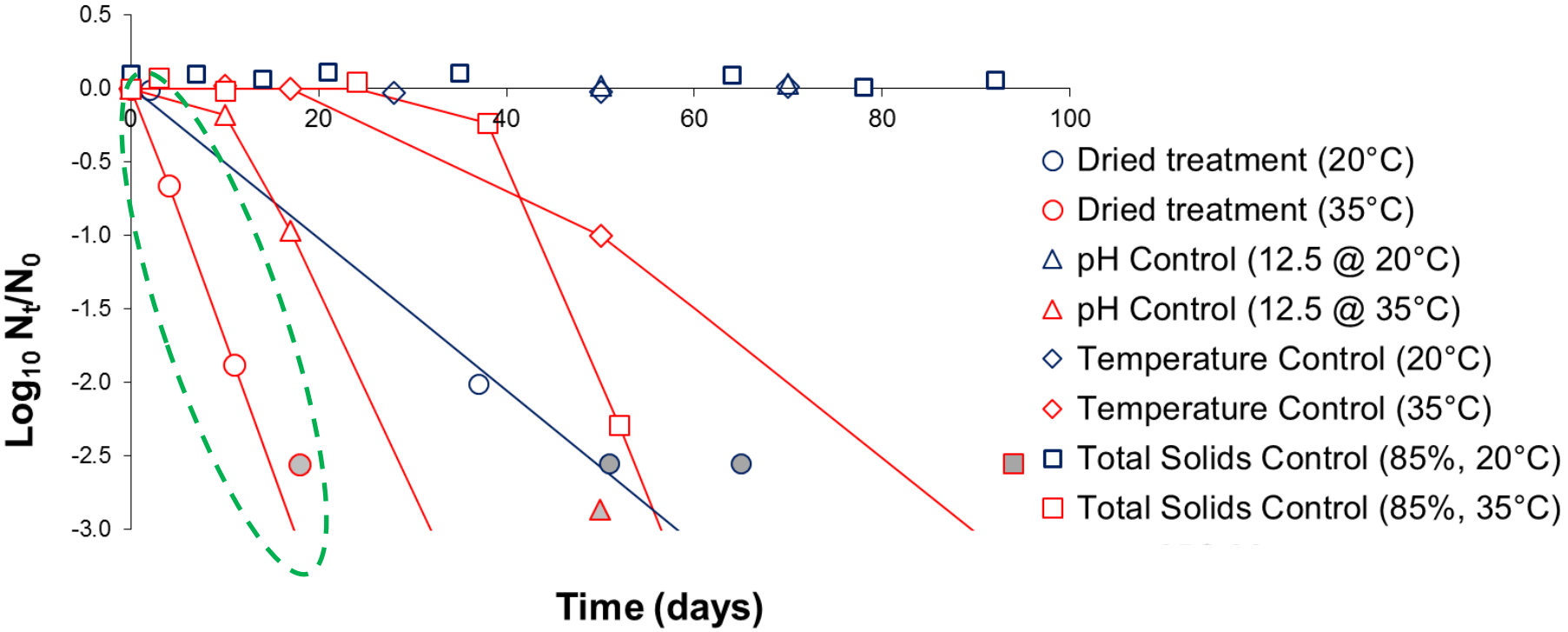

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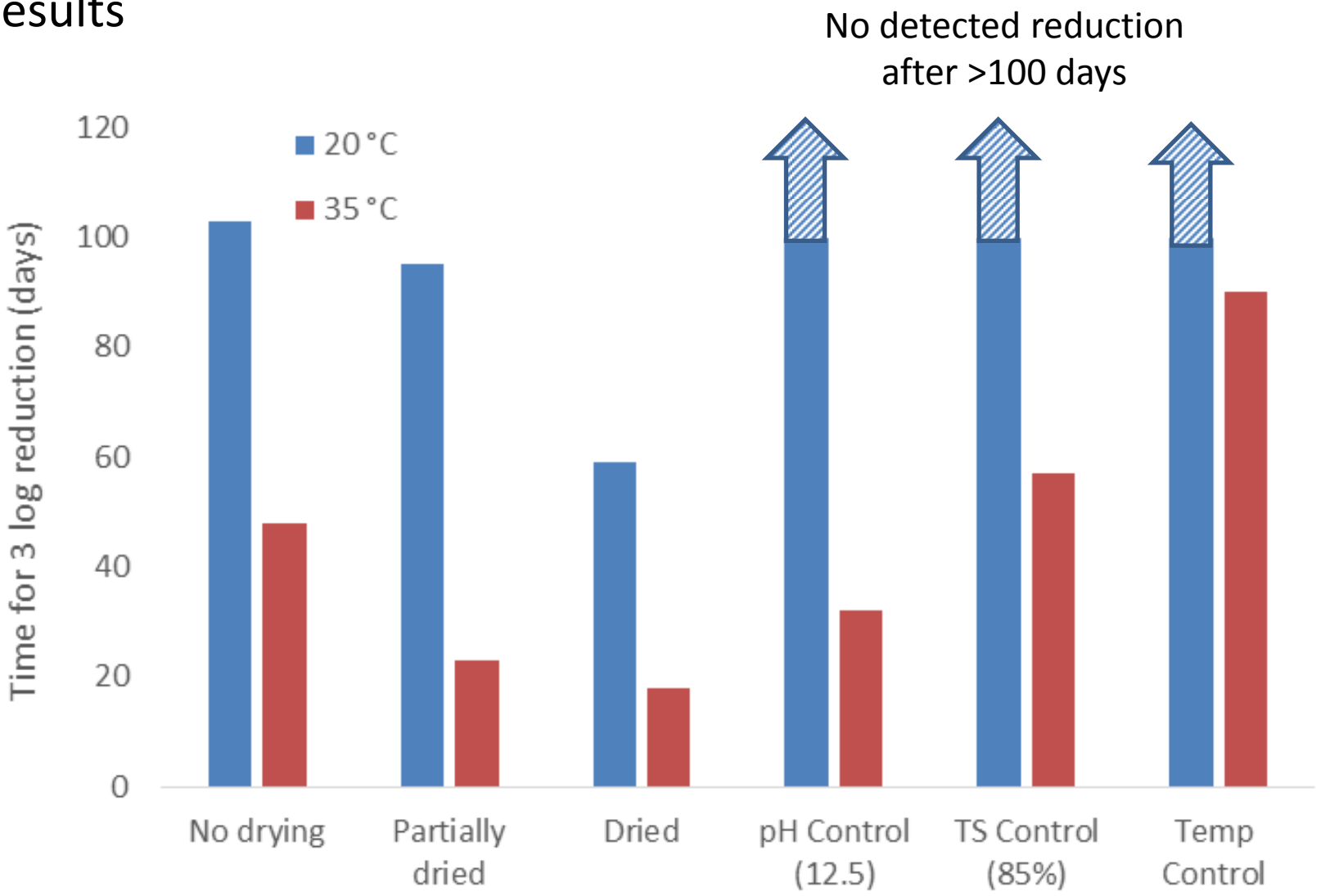

Conclusions

- Calcium hydroxide functioned to **stabilize** the urine to enable **evaporation** to produce a fertilizer high in N
- The treatment can have a 3 $\log_{10}$ reduction of Ascaris depending on the:
  - Duration of storage
  - Temperature of storage
  - Containers/bags being sealed to keep ammonia
- **Temperature** is the main driving factor of the inactivation of Ascaris
- Compounding effects of **pH and ammonia** increased with increased temperature

Thank you

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Autarky Team Spring 2015

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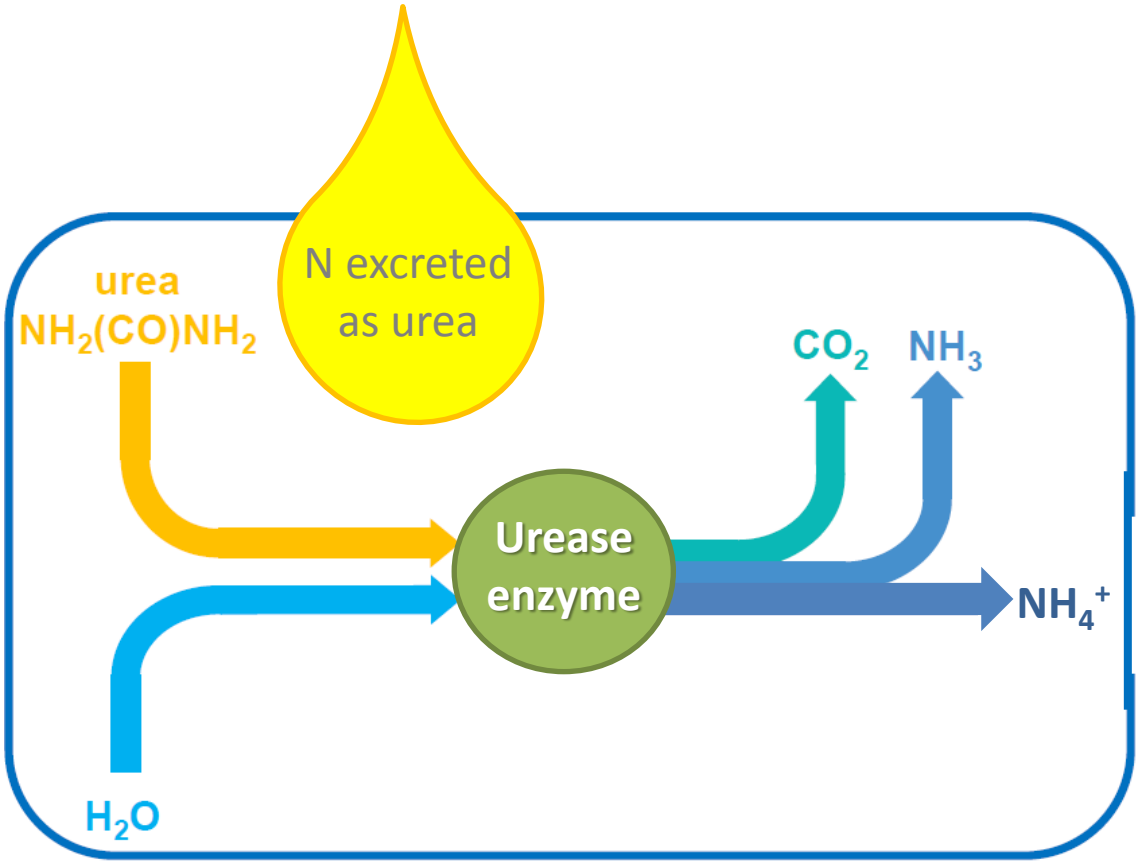
Retrofit


N excreted as urea
urea
$NH_2(CO)NH_2$
CO_2
NH_3
Urease enzyme
NH_4^+
H_2O