Helminth Eggs Die-off and Nutrients: Human Excreta Storage Experiment

Are the current practices of handling human excreta for agricultural purposes by farmers in Vietnam good enough? This study set up an excreta storage experiment to research how to inactivate *Ascaris lumbricoides* eggs and still maintain the nutrient value of human excreta.

T. Vu-Van[1,2,3], P. Pham-Duc[1], H. Nguyen-Viet[1,3,4,5], Ch. Zurbrügg[3], T. Huu Bich[1], J. Zinsstag[4]

Introduction

The use of human excreta as fertilizer creates economic and environmental benefits for farmers. However, it could pose potential health risks if not handled properly. In Vietnam, farmers often add locally available materials (e.g. ash, lime and rice husk) into excreta to reduce the bad smell and moisture content, and to prevent flies during excreta storage before using it as fertilizer. These current practices are likely to increase the inactivation of helminth eggs since dry conditions and increased pH often affect pathogen die-off. However, it is not yet clear if these practices meet the safety standards for the use of excreta in agriculture.

Excreta storage experiment and analyses

Our study tested the influence of different additive materials on helminth egg die-off in excreta, while maintaining its nutrient value, to improve the current practice of human excreta storage and identify the best option for the safe use of excreta in agriculture. The storage process we used simulated the current practices of farmers for excreta management.

First, we developed an experimental 24 vault storage system. Lime and rice husks were added into human excreta in varying proportions in the storage vaults and homogenously mixed to increase the pH (Table 1). Air pipes were introduced into 12 of the vaults to accelerate aeration. All the vault options met the WHO standard of hygienic quality for treatment of human excreta (< 1 egg per gram total solid).

Samples were taken from the vaults every two weeks over a 6.5 month period (sampling from T1 to T14). We used the Romannenko method to quantitatively analyse and count live and dead *A. lumbricoides* eggs and the Kendal method to measure the nutrient parameter (Nitrogen). The pH, temperature and moisture content were also recorded. A linear regression model of both uni- and multi-variable analyses was used to examine the effects of storage options, time, pH and temperature on the *A. lumbricoides* die-off.

Results

The number of live eggs per gram of sample decreased from 15 eggs to 0 eggs by the thirteenth sampling. Vault 42, containing 90 % latrine wastes mixed with 10 % powder lime, was the best option, reducing the number of live eggs to 0 over 4.5 months.

The average pH value progressively decreased from 10.6 to 7.9. The temperature inside the vaults varied from 17.4 to 32.6 °C, which was close to the ambient temperature. The linear regression model showed that the storage time and the mixtures in vaults 41 and 42 significantly influenced the die-off of *A. lumbricoides* eggs. The total explanation percentage in the regression model was 76.1 % by sampling the vault option, temperature, and pH.

The average percentage reduction of total nitrogen was 40 % (from 0.16 % to 0.55 %). The average percentage of total nitrogen per total solid decreased from 1.75 % (1.05 %; 2.17 %) at the first sampling to 1.35 % (0.89 %; 1.62 %) at the 11th sampling. However, the percentage reductions were not significantly different among the vault options ($p > 0.05$, two-way analysis of variance - ANOVA). It is also not clear what effects pH, temperature and moisture had on the die-off of *A. lumbricoides* eggs during the experimental period.

Conclusion

In conclusion, the study showed that the different additive materials did not greatly reduce the total nitrogen in the human excreta during the storage process. Yet, adding appropriate amounts of lime into excreta (10 kg lime / 90 kg latrine excreta – vault 42), coupled with enhanced aeration, quickly destroyed the helminth eggs, while maintaining the high nutrient values important for fertilizing agricultural fields. The results of this study could impact the way farmers in Vietnam handle human excreta for safe agricultural use.

Vault options	Excreta (kg)	Additive material (kg)		Air pipe	Replicate
		lime	rice husk		
11 (control)	100	0	0	No	3
12	100	0	0	Yes	3
21	97	3	0	No	3
22	97	3	0	Yes	3
31	90	5	5	No	3
32	90	5	5	Yes	3
41	90	10	0	No	3
42	90	10	0	Yes	3

Table 1: Experimental plan of excreta storage, air pipes, and additive materials

[1] Center for Public Health and Ecosystem Research, Hanoi School of Public Health, Vietnam
[2] Hoa Binh Medical Secondary School, Vietnam
[3] Sandec/Eawag, Switzerland
[4] Swiss Tropical and Public Health Institute, Switzerland
[5] International Livestock Research Institute, Vietnam

This work has been supported by the Swiss National Science Foundation and the Swiss Agency for Development and Cooperation through the National Centre for Competences in Research North–South Program.

Contact: vuvantu@gmail.com