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BIOLOGICAL STUDY ON RETENTION TIME OF MICROOGANISMS IN FEACAL MATERIAL IN URINE-DIVERTING ECO-SAN LATRINES IN VIETNAM

Bui Trong Chien, Döông Trong Phi, Bui Chi Chung
Nhatrang Pasteur Institute,10 Tran Phu St, Nhatrang Viet Nam
Nguyen Huy Nga
Ministry of Health, 138A Giang Vo St., Ha Noi, Viet Nam.
Thor Axel Stenstrom, Anneli Carlander, Therese Westrell.
Swedish Institute for Infectious Disease Control; SE-17182 Solna, Sweden.
Uno Winblad
International consulting group WKAB, Stockholm, Sweden

1. INTRODUCTION

Most Vietnamese live in rural areas, where only 17% of households have some kind of hygienic latrines. Several risk factors and habits have resulted an high infection incidence of parasitic diseases (60-80%) and diarrhea cases (1240 cases/100 000 people/year). The potential risk of epidemic outbreaks of intestinal diseases is ever present.

Common types of toilets are pit holes and traditional Vietnamese double vault. During the last fifteen years, double vault pour flush toilets have been introduced in rural areas. These types of toilets still have some weak points for protection of human health and environment. With the support of the Sida funded Sanres programme, the Nhatrang Pasteur Institute together with the Department of Preventive Health of the Ministry of Health, Viet Nam have developed o pilot ecological sanitation (eco-san) project in Cam Duc.

Cam Duc is a commune of Cam Ranh District, Khanh Hoa Province in Viet Nam. It is a hot and sunny place with a dry season lasting at least 8 months. The commune has 1,831 households with 9,940 inhabitants. The main occupation is farming. A third of the household have hygienic toilets and have dug well, most half of which are contaminated by faeces. The prevalence of intestinal parasite infection is 65% and diarrhea incidence is 1,100 cases/100,000/year.

The double-vault latrines have been conducted in Vietnam since 1956 until now. Since 1985, all types of latrines like pour flush, septic tank or double-vault latrine are allowed. But some of environmental specialists still have considered double-vault latrine unhygienic. So the aim of our study is evaluate the time needed for retention of faeces in the latrines before recycling as fertilizer with the least possible risk of the becoming sick or the infection with excreta-related pathogens.

The results of pilot project in Cam Duc will be applied to other rural areas in Vietnam.

2. MATERIALS & METHODS

Sixty eco-san systems in five different designs were built in bricks and cement mortar, roofed with galvanized iron or asbestos-cement sheets. Each solar heater (if there was) was made of iron sheet, fixed on an iron or wood frame and painted with tar. Two Vietnamese double-vault toilets served as controls. All were provided with urine diversion. The types can be identified as follows.

Type 1: Vietnamese traditional double-vault dehydrating toilet (VDVDT);

Type 2: Ventilated VDVDT (as type 1 but with a vent pipe);

Type 3: Ventilated double-vault dehydrating toilets with solar heater;

Type 4: Ventilated double-vault dehydrating toilet with removable shelter (as type 2 but with removable upper structure made in light materials and the uncover part of squatting slab serves as a solar heater);

Type 5: Ventilated one-bucket double-vault dehydrating toilet with solar heater;

Type 6: Ventilated multi-bucket one-vault toilet with solar heater.

Each householder got basic guidance in relation to the handling of his/her toilet before use. After all toilets were used at least 6 months, we chose 12 toilets, two of each type, for testing the survival time of microbial indicators in processing chambers of the toilets. Two indicator organisms were used: Salmonella typhymurium phages 28B & Ascaris suum eggs. The laboratory assays were modified and introduced by Swedish Institute for Infectious Disease Control.

The phages were mixed with faecal material in a concentration of 1.108 pfu/g. Eggs were put in "tea bags" made of polyamide cloth, with 104 eegs/bag. All were put in stainless steel cylinders, 11-14 cm in diameter, which were drilled a large number of 2 mm holes. Then the cylinders were put in 12 toilets processing chambers or toilets buckets, in the middle two-week to determine the survival time of phages and As. Eggs.

The pH, moisture and temperature were determined at the same time of sampling.

3. RESULTS AND DISCUSSIONS.

MOISTURE.
The initial moisture of the fecal materials when the tests started depended on the added quantity of ash by the users after defecation. The range was between 25.4% and 58.5% with a median value of 34,9%. The moisture decreased linearly by time of storage with a speed estimated from the slopes of the curves of moistures versus time (days) established by the minimum square method. The values are shown in Table 1.

Table 1: Drying speed of faecal material in processing chambers.

Types	1		2 *		3 **		4 **		5 **		6 **	
Toilet No	1	2	3	4	5	6	7	8	9	10	11	12
Drying speeds	0.07	0.08	0.18	0.12	0.16	0.16	0.12	0.21	0.08	0.10	0.25	0.08

(*) ventilated; (**)ventilated and solar heated; (***) best irradiated.

The drying speed of the toilets with solar heaters are normally higher than the traditional ones. However, their location does affect the efficiency. Which are fully irradiated like toilet 11 dried up rapidly.

TEMPERATURE.
In the toilets with solar heaters, the average air temperature in vault was 34.7°C, and the average temperature of materials was 33.9°C (the highest was 40.1°C), while the average out door air during the time of sampling was 32.4°C. The temperature of faecal piles was not high enough to kill pathogens but it took part in shortening their survival. For example, because the solar heaters of toilets 6 & 11 were fully exposed to the sun, the survival times of the two indicators were very short (see Table 2).

pH.
The pH values of the faecal material depended on the type and quantity of ash, which was added. The quantity used was about 100 -300 ml of ash. The pH of ash from wood was 11.3 and from rice-husks was the lowest. In our test, the pH seemed to be the most considerable factor in governing the die-off the organisms (see below)

THE DIE-OFF

The die-off of A.suum eggs was generally longer than that of Salmonella typhymurium phages. Their shortest die-off respectively was 51 and 23 days and the longest was 169 and 154 days.

Although theoretically the survival is affected by pH, temperature and moisture, the results observed showed that pH was the most influential factor. Truly, the statistical interpretation of relationship between the survival time of each indicator and three variables (% moisture, T^{o}C, pH) confirmed this (see Table 3).

The same interpretation base on maximum material temperature also gives us the similar results. Thus, we can say that in the range of pH from 8.4 to 10.3, temperature from 30.7 to 40.1^{o}C and moisture from 25.4 to 58.8% the survival time (as days) of two indicators can be evaluate by two following equations the confidence of 95%:

Yphages = -78.96pH - 5.328T^{o}C - 0.918M +1026
Phages = -49.96pH -0.684T^{o}C - 1.859M +646

And that at the critical probability of 0.05 only coefficients of pH are really statistically significant.

Table 2: The survival time of A. suum eggs and Sal. Typhymurium phages and three physical parameters

Number of Toilets	Survival time of		Average pH of faecal materials	Average T°C of faecal materials	Initial moisture of faecal moistures (%)
	Phages (days)	As. Eggs (days)			
1	37	79	9.8	31.2	35.6
2	79	65	9.6	31.2	41.5
3	37	65	10.0	30.7	34.1
4	37	169	10.1	30.7	40.4
5	154	129	8.4	32.8	34.0
6	23	65	10.1	34.8	28.8
7	93	65	8.8	34.2	58.5
8	114	142	9.0	35.3	39.8
9	23	65	10.3	31.4	32.1
10	23	51	10.3	32.5	25.4
11	30	51	9.5	36.2	49.9
12	30	65	9.7	33.4	32.6

Figure1: Concentration of Salmonella typhimurium phage 28B in the 12 test latrines

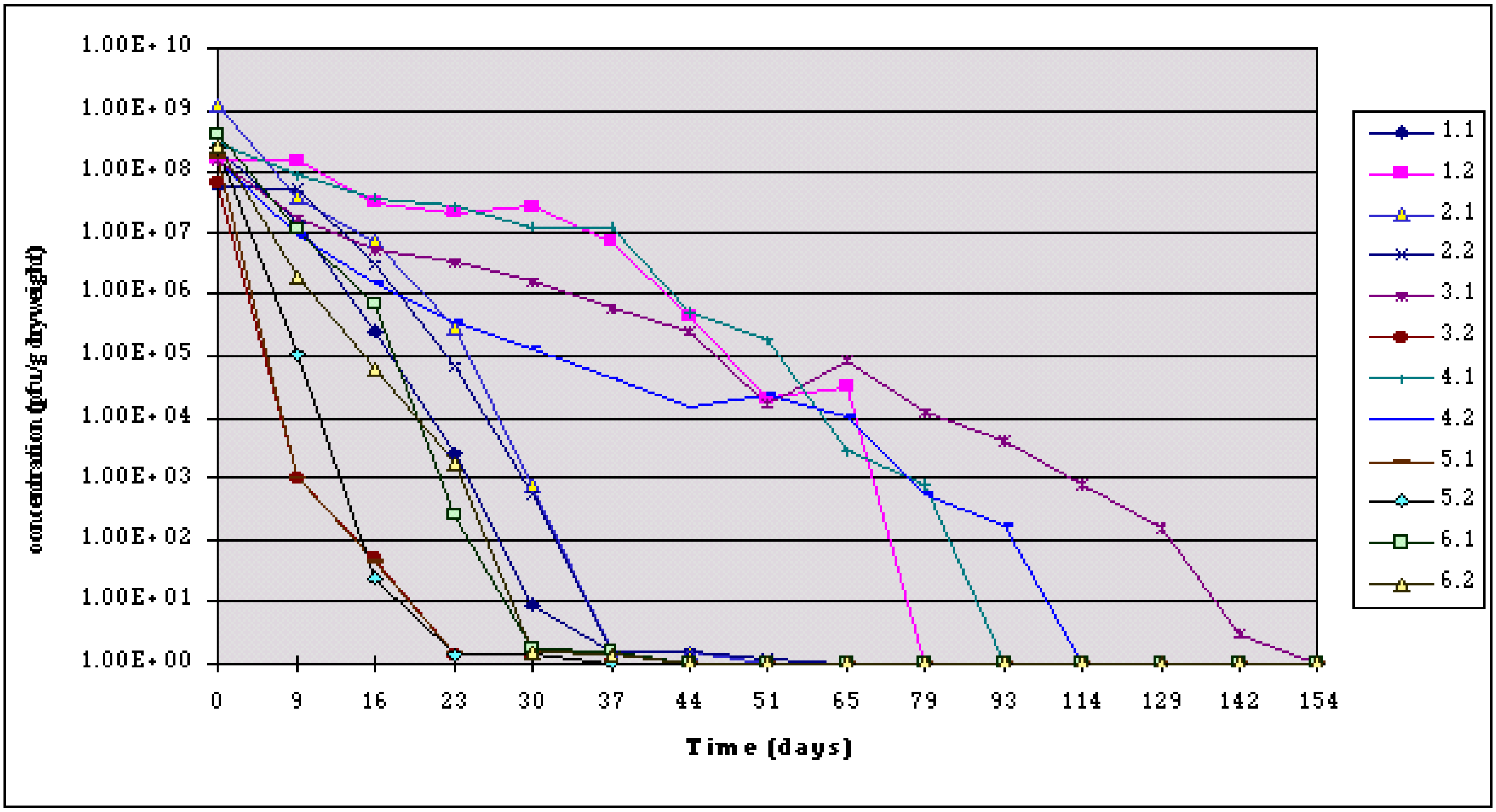

Figure 2: The time of surviving of Ascaris suum eggs in test latrines

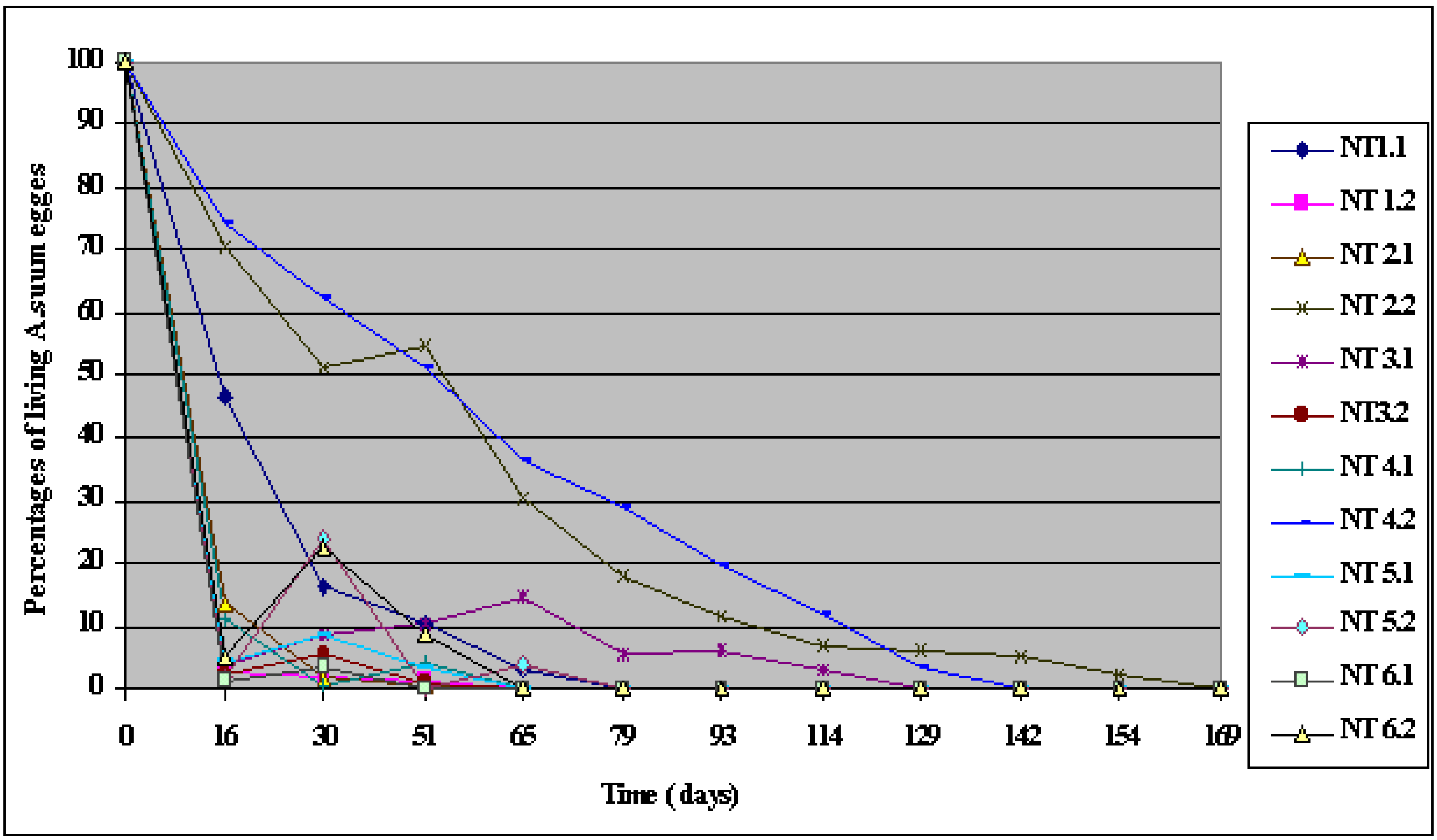

Table 3:Interpretation results given by Excel LINEST - function on the relationship between the survival time of

phages and As.eggs respectively and moisture. T°+C. pH (assume that their relationship obeyed the following equation):

Survival time $Y = m_1M + m_2T^o + m_3pH + b$

Indicators	m_1 (Moisture)	m_2 (T°C)	m_3 (pH)	B	r^2	F- test for r^2	
						F-observed	F-critical
Sal. phages	-0.918 (/t/=0.678)	-5.328 (/t/=1.797)	-78.96 (/t/=8.314) *	1026	0.9188	26.4	4.76 (P=0.05)
As. suum eggs		-0.684 (/t/=0.181)	-49.694 (/t/=4.103) *	645.7	0.795	5.695	4.76

(*) t-critical = 2.365 at p = 0.05

NITROGEN FORMS IN FEACAL FROM 6 TYPES OF TESTET TOILETS (% DRY WEIGHT)

	N total (%)	N inorganic (%)	N inorganic/ N total (%)
Toilet 1.1 +1.2	0.84	0.01	1.20
Toilet 6.1 + 6.2	0.94	0.005	0.05
Average (n=6)	0.74	0.016	2.20

According to the data in above table, Nitrogen content in toilet feacal product is not high. It is clear that why we need to use urine-diverting latrines.

Feacal product of dry latrines is not composed. The process of decomposition in dry latrines is not significant. The process will mainly happen on field.

4. CONCLUSIONS AND RECOMMENDATIONS

- Factor pH plays the most important role in killing microorganisms in feacal material.
- PH and moisture content have a great affect on the reduction of the bacteriophages when the temperature below 400C.The temperature is not high enough to play significant role in reductions of the microorganisms.
- It takes 6 months of retention for faecal materials in the test toilets to become absolutely safe.
- Ash from wood is the best additive for shortening the survival time of the microorganisms and parasites in faeces and removing bad odour. Such ash is readily available in every Vietnamese rural household.
- Although the survival time of the indicators in the majority of toilets having solar heaters is relatively shorter, the operation of these toilets is more inconvenient and the construction more difficult.
- Ventilation pipes, 10 cm in diameter and reaching at least 50 cm above the toilet roof, can effectively remove odour and control flies.
- Proper use is very important for these toilets to function well.
- The is no process of decomposition in tested latrines. Feacal product is not good enough to use as fertilizer.