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Short Communication

Hygienic aspects of livestock manure management and biogas systems operated by small-scale pig farmers in Vietnam

Luu Quynh Huong [a,b], Henry Madsen [b], Le Xuan Anh [c], Pham Thi Ngoc [a], Anders Dalsgaard [b,*]

[a] National Institute of Veterinary Research, 86 Truong Chinh road, Dong Da district, Hanoi, Viet Nam
[b] Department of Veterinary Diseases Biology, Faculty of Health and Medical Sciences, University of Copenhagen, Grønnegårdsvej 15, DK-1870 Frederiksberg C, Denmark
[c] Hue Universities of Agriculture and Forestry, 120 Phung Hung Road, Hue, Viet Nam

HIGHLIGHTS

- Biogas systems in Vietnam receive both pig manure and human excreta.
- *E. coli* is reduced by only 1 to 2 log units in biogas systems.
- Biogas effluent is used to fertilize vegetables and contaminate the environment.
- Reduced problems with bad smell and flies are main reasons for having biogas units.
- Human health hazards associated with use of biogas effluent should be assessed.

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ABSTRACT

Biogas digesters are widely promoted and increasingly used to treat and generate gas from pig slurry worldwide. The objective of this study was to describe manure management practices with focus on biogas digestion among small scale pig farmers in Hue (50 farmers) and Hanoi (96 farmers) and to assess fecal contamination levels in biogas effluent. Results showed that 84% of the farmers in Hanoi and 42% in Hue used both pig slurry and human excreta for biogas production. Biogas digestion only reduced *E. coli* concentrations by 1 to 2 log units to 3.70 ± 0.84 *Escherichia coli* ($\log_{10}$) cfu/ml on average in effluent as compared with raw slurry. Biogas effluent was commonly used to fertilize vegetables or discharged directly into the garden or aquatic recipients. Reduced problems with bad smells and flies were reported as main reasons for establishing a biogas digester. Further studies are needed to assess human and animal health hazards associated with the discharge and use of biogas effluent from small-scale biogas systems.

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1. Introduction

Pig production is rapidly increasing in Vietnam and other Asian countries because of increased consumer demands for pork. As a result large volumes of animal manure has to be managed in a sustainable manner by optimizing usage of the nutrients and energy in the manure while at the same time minimizing the negative impact on the external environment, food safety and human health. It is common among family households in Asian countries to keep pigs and about 80% of the total pig production in Vietnam is still in the hands of such smallholders which often raise pigs in farm systems integrated with fish and horticulture.

Insufficiently treated manure is often released into the environment polluting the air and water, including drinking water sources, as well as contaminating food crops with mainly bacterial and parasitic helminth pathogens where the latter includes *Ascaris* spp. and *Fasciolopsis buski*, a large intestinal trematode prevalent in Vietnam and transmitted through consumption of contaminated freshwater plants (Chai et al., 2009; Jean-Yves et al., 2008). In Vietnam, farmers typically mix pig manure with straw and lime which is then stored in heaps covered by a mud layer for 3–4 months or until the manure is needed as a crop fertilizer. Anaerobic digestion of animal manure has been practiced in Vietnam since the 1960s, but the popularity of biogas technology has grown; in particular since the promotion by government and non-governmental organizations began in 2003 with more than 100,000 biogas units now being built. Different biogas systems have been designed to meet the requirements of different livestock farming

* Corresponding author at: Department of Veterinary Diseases Biology, Faculty of Health and Medical Sciences, University of Copenhagen, Grønnegårdsvej 15, DK-1870 Frederiksberg C, Denmark. Tel.: +45 35332720; fax: +45 35332755.
E-mail addresses: lqhuong@sund.ku.dk (L.Q. Huong), hmad@sund.ku.dk (H. Madsen), lexuananh79@yahoo.com (L.X. Anh), ngoc27169@yahoo.com (P.T. Ngoc), adal@sund.ku.dk (A. Dalsgaard).

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systems (BP, 2011). At the household level, the digesters are often fed pig slurry and occasionally also toilet waste. Little is known about the hygienic quality and possible presence of pathogens in the biogas effluent and this is a health concern as the effluent is typically used to fertilize garden crops or simply discharged into the environment. The aim of this study was therefore to describe hygienic aspects of livestock manure management and use practices among Vietnamese farmers and to assess the concentration of *Escherichia coli*, an indicator of fecal pathogens, in biogas effluent.

2. Materials and methods

2.1. Animal manure management practices and biogas systems of pig farmers

A questionnaire interview survey was conducted from March to May 2010 in two communes located near the capital of Hanoi and two communes near Hue city, Vietnam. A total of 181 and 100 pig farms were randomly selected in Hanoi and Hue, respectively. Questionnaire interviews of the farmer households were conducted to collect information with particular attention to hygienic aspects of manure management. The biogas system used by most of the pig farmers was the so-called KT1 biogas model (Fig. 1) (BP, 2011; Khai and Luong, 2010).

2.2. Microbiological analyses of manure and biogas effluent

2.2.1. Sampling

Among the interviewed households in the two communes near Hanoi, 20 farms were selected for quantitative analysis of *E. coli* and helminth parasite eggs in different manure types. Five farms with a biogas digester and five farms without a biogas digester were randomly selected from lists of farms provided by the Local Department of Agriculture. Samples of solid manure, slurry and biogas effluent were collected from each farm. Solid manure subsamples of approximately 1000 g were collected from 3 to 5 locations in the pig pen in the morning before the pen was cleaned. The collected manure was placed in a clean bucket and mixed well after which an approximately 200-g sample was transferred to a labeled sterile plastic box. At farms without a biogas digester, slurry was typically collected and stored in a tank. At farms with a biogas digester, an approximately 1000 g slurry sample was collected from the inlet tank (Fig. 1). During cleaning of pig pens at farms without an inlet tank, a total of approximately 1000 g of slurry was collected at 15–30 min time intervals just before the slurry entered the biogas digester tank. The slurry samples were mixed well in a clean bucket and a 200-g sample was transferred to a labeled sterile plastic box. Some biogas farms had an effluent tank that continuously received digestate from the compensation tank whereas other farms discharged effluent directly from the compensation tank to the surrounding areas, e.g. the household garden, a fish pond or another aquatic recipient. Samples of approximately 1000 ml were collected from the effluent storage tank or from where effluent was discharged (Fig. 1). Following homogenization by stirring with a sterile spoon a sub-sample of 200 ml was collected in a sterile bottle. All types of manure samples were transported in an insulated ice-box to the laboratory and analyses initiated on the day of sampling.

2.2.2. Enumeration of E. coli and helminth eggs

Analysis for *E. coli* was done on Brilliance *E. coli*/coliform Selective Agar (CM1046, Oxoid, Basingstoke, UK). Briefly, 10-g sub-samples of solid manure, slurry or effluent were weighed into a sterile stomacher bag containing 90 ml (1:10) Maximum Recovery Diluent (MRD) (CM0733, Oxoid). The sample was homogenized in a stomacher at 3000 rpm for 1 min and appropriate ten-fold serial dilutions were prepared in MRD. Volumes of 100 μl of each dilution were surface spread onto the Brilliance *E. coli*/coliform Selective Agar and incubated at 37 °C for 24 h. The total number of *E. coli* (cfu/ml) was calculated based on the number of colonies enumerated on agar plates representing two subsequent ten-fold dilutions.

Ascaris suum was enumerated using a flotation method (Raynaud, 1970). Briefly, samples of 3 g were placed in a plastic cup and a saturated-salt–sugar solution added to a total volume of 60 ml which was mixed thoroughly with a stirring device. After sedimentation, the suspension was filtered through a 400 μm sieve into a Falcon tube. After thoroughly stirring, a 2-ml sample was transferred to a McMaster counting chamber using a Pasteur pipette. Helminth eggs were counted under a microscope at 100× magnification and presented as eggs per gram (epg) of sample.

F. buski is a large zoonotic intestinal fluke that infect humans and pigs through ingestion of water or raw vegetables contaminated with parasite cysts, e.g. aquatic vegetables fertilized with manure (CDC, 2010). As *F. buski* has been reported in Vietnam (Yoshihara et al., 1999), it was detected in the present study by a sedimentation method (Young and Trajstman, 1980). Briefly, a 5-g sample was placed in a plastic cup, and then 100 ml of tap water was added. The mixture was homogenized by stirring vigorously. The fecal suspension was filtered through a 200 μm sieve into a sedimentation glass which was then filled up with tap water and after 10 min of sedimentation the supernatant was decanted. This process was repeated three times and then the final sediment was processed and eggs enumerated as described for *A. suum* with the use of 40× magnification.

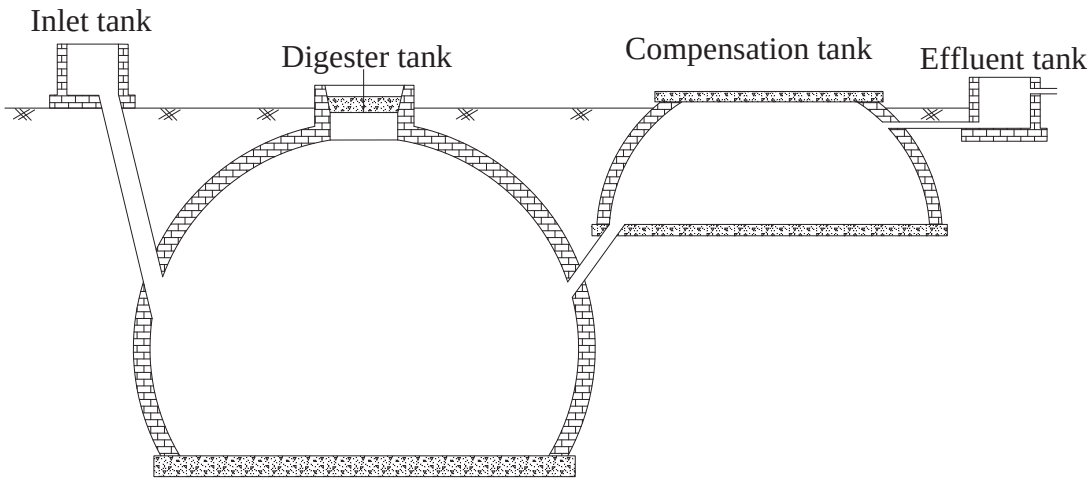

Fig. 1. Illustration of a biogas digester type (KT1) used by many small-scale pig farmers in northern Vietnam.

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