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1)

Field study of concentrations and emissions of biological contaminants by types of pig buildings in Korea

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Inhalation of biological contaminants in pig building can be detrimental to farm worker's health effects such as infection, allergy, or toxicosis. The principal aim of this field study was to determine the concentrations and emissions of biological contaminants, that is, total airborne bacteria and fungi, in the different types of pig buildings in Korea and allow objective comparison between Korea and the other countries in terms of swine housing types. Pig buildings in this research were selected with three criteria such as manure removal system, ventilation mode and growth stage of pig. Measurements of concentration and emission of total dust and respirable dust in the pig buildings were performed in 5 housing types and 15 farms. Concentrations of total airborne bacteria and fungi in the pig buildings were averaged to 4.13 log(cfu/m³) and 3.14 log(cfu/m³) and ranged from 1.16 to 10.26 log(cfu/m³) and from 0.48 to 6.86 log(cfu/m³), respectively. The highest concentrations of total airborne bacteria and fungi were found in the pig buildings with deep-litter bed system; 5.76 mg/m³ and 5.14 mg/m³, while the lowest concentrations of total airborne bacteria and fungi were found in the naturally ventilated buildings with slats; 2.52 log(cfu/m³) and 1.84 log(cfu/m³)(p<0.05). The mean emissions of total airborne bacteria and fungi per pig(75kg in terms of liveweight) and area(m²) from pig buildings were 0.98 log(cfu)/h/pig and 0.73 log(cfu)/h/pig

and 1.32 log(cfu)/h/m² and 0.96 log(cfu)/h/m², respectively.

The pig buildings with deep-litter bed system showed the highest emissions of total airborne bacteria and fungi(p<0.05). However, the emissions of total airborne bacteria and fungi from the other pig buildings were not significantly different. This study showed that the mean concentrations of total airborne bacteria and fungi in the pig buildings situated in Korea were generally lower than those in other countries. The mean emissions of total airborne bacteria and fungi in the pig buildings showed little differences between Korea and other countries. In conclusion, the concentrations and emissions of total airborne bacteria and fungi were relatively higher in the pig buildings which are managed with deep-litter bed system and ventilated naturally than the different swine housing types. In further research, the more farms than case of this research should be investigated to present an objective and accurate data for concentrations and emissions of total airborne bacteria and fungi in the pig buildings in Korea. In addition the threshold limit values(TLVs) for total airborne bacteria and fungi should be suggested to assess the health risks of farm workers exposed to biological contaminants.

Key Words: Pig building, Farm worker, Bioaerosol, Airborne bacteria, Airborne fungi

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I. 서 론

가

(Wathes et al., 1998; Chang et al., 1991; Gay et al., 2003)
(Attwood et al., 1987; Gustafsson, 1999; Duchaine et al., 2000)

가

Enterobacter agglomerans, *Moraxella*, *Acinetobacter calcoaceticus*, *Pseudomonas*가, *Scopulariopsis*, *Apergillus*, *Penicillium*, *Candida*가

(
2003; , 2003)
가

(Casal et al., 1995; Sorensen et al., 2001).

가

(bioaerosol)

(Clark et al., 1983; Thorne et al., 1992; Griffiths and Decosemo, 1994).

가

II. 실험대상 및 방법

1. 조사 대상 선정

(Clark et al., 1983; Crook et al., 1991; Duchaine et al., 2000; Chang et al., 2001).

가 5 (< 1>).

가

(Deep-pit manure

system with slats),
(Manure removal system by scraper),
(Deep-litter bed system) ,

, Elliott (1976)

*Staphylococcus*가

Salmonella

. Cormier (1990)

(winch-curtain)

(Donham et al.,

1986; Bruce and Sommer, 1987; Crook et al., 1991; Olson and Bark, 1996).

50 ~ 100kg /

Table 1. Details of the swine houses investigated in this research

Housing type		Pig type	No.
Manure collection system	Ventilation mode		
Deep-pit manure system with slats	Natural ventilation.	Growing/Finishing	15
	Mechanical ventilation	Growing/Finishing	15
Manure removal system by scraper	Natural ventilation.	Growing/Finishing	15
	Mechanical ventilation	Growing/Finishing	15
Deep-litter bed system	Natural ventilation.	Growing/Finishing	15

가 . chloramphenicol 100mg 가
15 . 37
Thorne (1992) 1 ~ 2 , 25
(1% peptone + 0.01% Tween 80 3 ~ 5
+ 0.005% antifoaming agent) 10mL
(Ace Glass Inc., Vineland, N.J.)
autoclave 150 , 2
30 .
가 4
2 /min
15 ~ 30
SAS package(1999) ANOVA
Duncan
150cm
4
III. 실험결과 및 고찰
1. 돈사 작업장 유형에 따른 총 부유
세균과 총 부유진균의 실내 농도
및 원단위 발생량
CO₂ 75% clean bench
5
shaking micropipet 100
μL , 10 105
CO₂ 3
NA(Nutrient Agar) 4.13 log(cfu/m³) ,
1.16~10.26 log(cfu/m³)
(Beef extract 3g; Peptone 8g; NaCl 5g; 가
Agar 18g; + 1) , 가
가 cycloheximide 500mg 가 ,
MEA(Malt Extract Agar) , 가
가 (Malt extract 20.0g; Dextrose 20.0g;
Peptone 1.0g; Agar 20.0g; + 1) (p<0.05),
75kg ,

Table 2. Concentration of total airborne bacteria and fungi according to types of swine housing facilities in Korea

Housing type		Total airborne bacteria log(cfu/m ³)		Total airborne fungi log(cfu/m ³)	
Manure collection system	Ventilation mode	Mean	Range	Mean	Range
Deep-pit manure system with slats	N.V.*	‡2.52 ^a	1.91 - 4.18	1.84 ^a	0.48 - 2.87
	M.V.†	3.83 ^b	1.24 - 4.83	2.75 ^b	1.04 - 3.85
Manure removal system by scraper	N.V.	3.52 ^b	1.16 - 5.35	2.83 ^{bc}	1.24 - 4.64
	M.V.	5.04 ^b	2.13 - 8.37	3.14 ^c	0.91 - 4.88
Deep-litter bed system	N.V.	5.76 ^c	2.57 - 10.26	5.14 ^d	2.85 - 6.86
Total Mean		4.13	1.16 - 10.26	3.14	0.48 - 6.86

* : Natural ventilation

†: Mechanical ventilation

‡: a, b, c and d means that averaged values within the row by the same letter are not significantly different.

(Table 2).

3.14 log(cfu/m³) 가 가

, 0.48 log(cfu/m³)

6.86 log(cfu/m³) 가 1 log(cfu/m³) (p<0.05),

가 가 (Table 2).

. 가 Table 3 .

(m²)

가 가 (m²) 0.96 log(cfu)/h/m²,

1.32 log(cfu)/h/m², (75kg) 0.73 log(cfu)/h/pig가

(p<0.05). 0.98 log(cfu)/h/pig가 (Table 4).

. 0.35~3.28 log(cfu)

, 0.42~4.28 log(cfu)/h/m² /h/m² 0.24~2.24 log(cfu)/h/pig

0.33~2.67 log(cfu)/h/pig 가

Table 3. Emission of total airborne bacteria according to types of swine housing facilities in Korea

Total airborne bacteria					
Housing	log(cfu)/h/*pig		log(cfu)/h/m ²		
Manure collection system	Ventilation type	Mean	Range	Mean	Range
Deep-pit manure system with slats	†N.V.	§0.76 ^b	0.45 - 1.18	1.02 ^a	0.58 - 2.06
	‡M.V.	0.68 ^{ab}	0.51 - 1.67	0.91 ^a	0.63 - 2.57
Manure removal system by scraper	N.V.	0.92 ^b	0.48 - 1.75	1.24 ^a	0.55 - 3.16
	M.V.	0.88 ^b	0.33 - 2.14	1.18 ^a	0.42 - 3.96
Deep-litter bed system	N.V.	1.67 ^c	0.84 - 2.67	2.24 ^b	1.14 - 4.28
Total Mean		0.98	0.33 - 2.67	1.32	0.42 - 4.28

* : Based on growing/finishing pig(75kg)

†: Natural ventilation

‡: Mechanical ventilation

§ : a, b and c means that averaged values within the row by the same letter are not significantly different.

1990; Walter et al., 1990)

가

가 (p<0.05), 가 (Barber et al., 1991; Klooster et al., 1993)

가

가

가

가

2. 외국 선행 연구 자료와의 비교

가 Table 5

가

(Marthi and Lighthart, 1990; Walter et al., 1990).

가 5.33 log(cfu/m³) 4.13 log(cfu/m³)

(Donaldson, 1978; Robertson and Friebe, 1984).

Seedorf (1998) Takai (1998) log(cfu/m³) 3.14 3.35 log(cfu/m³)

가

가

가

가 (pit)

가

(Salvin, 1949; Marthi and Lighthart,

Table 4. Emission of total airborne fungi according to types of swine housing facilities in Korea

Total airborne fungi					
Housing	Ventilation type	log(cfu)/h/*pig		log(cfu)/h/m ²	
		Mean	Range	Mean	Range
Manure collection system with slats	†N.V.	§0.51 ^a	0.24 - 0.81	0.69 ^b	0.35 - 1.31
	‡M.V.	0.48 ^a	0.26 - 1.03	0.65 ^{ab}	0.44 - 1.82
Manure removal system by scraper	N.V.	0.62 ^a	0.35 - 0.93	0.83 ^b	0.56 - 1.54
	M.V.	0.73 ^a	0.44 - 1.11	0.98 ^b	0.68 - 2.24
Deep-litter bed system	N.V.	1.32 ^b	0.61 - 2.24	1.77 ^c	0.73 - 3.28
Total Mean		0.73	0.24 - 2.24	0.96	0.35 - 3.28

* : Based on growing/finishing pig(75kg)

†: Natural ventilation

‡: Mechanical ventilation

§ : a, b and c means that averaged values within the row by the same letter are not significantly different.

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