GASEOUS EMISSIONS IN THE RAISING OF WEANED PIGS ON FULLY SLATTED FLOOR OR ON STRAW-BASED DEEP LITTER

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Introduction

Gaseous emissions from agriculture contribute to a number of environmental effects. Ammonia emissions are responsible of soil acidification and eutrophication. Carbon dioxide, methane and nitrous oxide are greenhouse gases taking part to the global problem of climate change. The global warming potential (GWP) is estimated to 21 for methane and 310 for nitrous oxide times the GWP of CO_2 (Billiard, 1998). Gaseous emissions from livestock houses are dependant from the housing and floor systems. Very few experiments have compared in standardized conditions gaseous emissions according to floor systems. The aim of the study was to compare emissions from a pig house with weaned pigs either on a fully slatted floor or on a deep litter.

Material and methods

Two identical rooms with an area of 30 m^2 and a volume of 103 m^3 were arranged to house simultaneously a group of 40 weaned pigs on a fully slatted floor in one and on a deep litter of straw in the other one. The slatted floor was in plastic panels with a void percentage of 37%; the floor area was 0.3 m^2/pig. The slurry pit was 50 cm deep. Before the arrival of the first animals, 600 l water were poured into the pit to have a 5 cm water layer in the bottom. Straw deep litter was realized with a 30 cm layer before the arrival of the animals. Thereafter supplementary quantities of straw were provided depending on the cleanliness of the litter. The available floor space per animal was 0.5 m^2. The total amount of straw used was 8 kg/pig.

Each room was ventilated with an exhaust fan. Fresh air entered through an opening which was connected to the service corridor of the building. The air temperatures of the two rooms and the corridor were measured automatically every hour. The ventilation rates were measured continuously and the hourly means were recorded with an Exavent apparatus (Fancom®).

In each room, two successive batches of 40 pigs were raised, without changing the litter or emptying the slurry pit between batches. The pigs were fed ad libitum, food containing 176 g crude protein per kilo. The quantities of food ingested and water consumed were determined per batch.

The concentrations of gases in the air in the two experimental rooms and the corridor supplying fresh air were measured with an apparatus from Innova Air Tech Instruments (1312 Photoacoustic Multi-gas Monitor) equipped for the measurement of NH_3, N_2O, CH_4, CO_2 and H_2O. For each batch, the concentrations were measured three times at about one week intervals and for 6 consecutive days respectively. The multi-gas monitor was programmed by conducting 2 measurements per hour at each sampling point. The emissions were calculated on an hourly basis utilizing the following formula : $E\ (mg \cdot h^{-1}) = D \times (C_i - C_e)$ with D, the hourly mass flow (kg air$\cdot h^{-1}$); C_i and C_e the hourly concentrations of gas in the air of the room or corridor (mg$\cdot kg^{-1}$ dry air). The mean emissions per pig per day were calculated for each series of measurements.

For each batch and each gas and for the combined data obtained with the two batches, the differences of the emissions with regard to the floor system were tested in the form of a mixed model for repeated measurements (SAS, proc MIXED).

Results

Climatic characteristics of the rooms

The average temperatures of the air were 26.4°C in the room with the slatted floor and 23.9°C in the room with the deep litter. The mean ventilation rates were 238 and 216 m^3/h for the two rooms respectively.

Performance of the pigs

The mean initial and final weights were respectively 7.2 ± 1.15 kg and 23.55 ± 3.3 kg. There was no significant difference between the daily weight gain of the pigs raised on deep litter (387 ± 65 g/day) or on slatted floor (379 ± 64 g/day). The food conversion ratio (kg/kg) were respectively 1.57 on deep litter and 1.74 on slatted floor.

Amounts and composition of manure

The amounts of slurry and of straw manure removed at the end of the experiment were respectively 37.0 kg per pig at 163 g dry matter (DM) per kg and 27.5 kg per pig at 326 g DM per kg. The slurry and deep litter nitrogen contents were respectively 64.5 g and 30.7 g per kg DM or 389 and 276 g per pig.

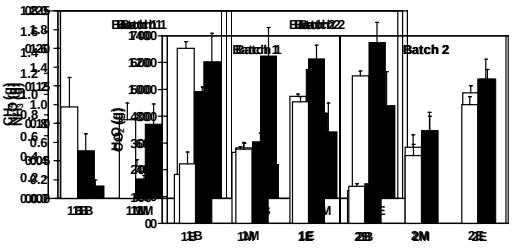
Gas emissions

Figure 1 shows the evolution of the emissions from the beginning to the end for each post-weaning period. Table 1 presents the mean emissions observed for each batch.

Over the 2 post-weaning periods altogether, pig raising on deep litter produced proportionately 100% more NH_3, 5% more CO_2, 16% more H_2O and 18% less methane than pig raising on slatted floor. Differences were however significant only for NH_3.

No N_2O was produced from the slurry and the emission from the deep litter was observed only during the stay of the second batch.

Figure 1. Gas emission (per pig per day) during the raising of 2 batches of weaned pigs on slatted floor (open bars) or on straw (closed bars). Three series of measurements per batches (mean ± s.d.) at the beginning (B), middle (M) and end (E) of the post-weaning periods.



Gas emissions increased regularly from the beginning to the end of each post-weaning period whatever the floor system.

Table 1. Gas emission (per pig per day) in the raising of two batches of weaned pigs on slatted floor or on straw.

		Slatted floor	Straw	s.e.	S
Batch 1	NH_3 (g)	0.35	0.80	0.18	
	N_2O (g)	0.00	0.00	-	
	CH_4 (g)	1.03	0.56	0.06	*
	CO_2 (g)	308	327	38.1	
	H_2O (g)	634	694	104	
Batch 2	NH_3 (g)	0.41	0.69	0.18	
	N_2O (g)	0.00	0.09	0.04	
	CH_4 (g)	0.79	0.95	0.09	
	CO_2 (g)	298	340	28.6	
	H_2O (g)	556	685	99.8	
Batch 1 and 2	NH_3 (g)	0.38	0.74	0.08	*
	N_2O (g)	0.00	0.05	0.02	
	CH_4 (g)	0.91	0.75	0.10	
	CO_2 (g)	303	334	19.7	
	H_2O (g)	595	689	48.1	

s.e. : mean standard error S : significance

Discussion

The emission of NH_3–N from piggeries with slatted floors is estimated to be 23% of excreted nitrogen (Guillou et al., 1993). In this experiment the NH_3–N emission from the slurry was only of 5% of wastes–N. The measurement period was however limited to 85 days and at the beginning of the experiment the slurry pit was clean with a 5 cm water layer in the bottom. In comparison, the NH_3–N emission from the deep litter was 17% of wastes–N. N_2O–N emission from the deep litter was 1% of wastes–N and emission of N_2 from the deep litter was estimated to be 17% of wastes–N. The cumulative N emission from these 3 gases was thus 35% of wastes–N. This value is lower than that observed in a previous experiment (59%) when five successive batches of weaned pigs were raised on the same litter without changing the litter between batches (Nicks et al., 2003). No N_2O production was observed from the slurry and according to the nitrogen balance these was no production of N_2. As a consequence the N content of the slurry was about 41% higher than that of the deep litter.

The levels of CH_4 emissions observed in this experiment suggest that the productions both in the slurry and in the deep litter were very low and that CH_4 in the 2 experimental rooms come essentially from the digestive tract of animals. In the same way, levels of CO_2 emissions indicate that the respiration of the animals was the principal source of CO_2 in the experimental rooms. So there was no significant difference in relation with the floor system.

In conclusion, the main differences concerning the environmental effects of rearing weaned pigs either on slatted floor or on deep litter are : a lower NH_3 emission when pigs are on slatted floor and a lower N content of the manure when they are kept on deep litter.

Acknowledgements

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