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

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Introduction

Gaseous emissions from agriculture contribute to several environmental effects. Ammonia emissions are responsible of soil acidification and eutrophisation. Carbon dioxide, methane and nitrous oxide are greenhouse gases taking part in the global problem of climate change. Gaseous emissions from livestock houses are dependent from housing and floor systems. The aim of the study was to compare emissions from a pig house with fattening pigs either on a fully slatted floor or on straw-based deep litter.

Material and methods

Two identical rooms were arranged to house a group of fattening pigs on a concrete fully slatted floor (void percentage of 15.6 %) in one and on a straw-based deep litter in the other one. Each room had a 30 m^2 horizontal area and a volume of 103 m^3. The available floor space was 0.75 m²/pig on slatted floor and 1.35 m²/pig on deep litter. Pigs were given food *ad libitum*. During the first 4 weeks, they received food containing (per kg) 181 g crude protein and 10.2 g lysine. This was progressively replaced by food with 175 g crude protein and 9.0 g lysine. Before the arrival of animals, water was poured into the slurry pit to have a 5 cm layer, and 375 kg of straw were use to constitute the deep litter. Straw was supplied regularly throughout the fattening period. Two successive batches of 16 pigs were raised in each pen. The slurry pit was emptied and the litter removed between the two batches.

Each room was ventilated with an exhaust fan. The ventilation rates were measured continuously and recorded with an Exavent apparatus (Fancom®). The concentrations in the air of experimental rooms and corridor supplying fresh air were measured with a 1312 Photoacoustic Multi-gas Monitor (Innova Air Tech Instruments) equipped to measure ammonia (NH_3), nitrous oxide (N_2O), methane (CH_4), carbon dioxide (CO_2) and water vapour (H_2O). During the stay of each batch, the gas concentrations were measured during 4 periods of 6 consecutive days with a 1-month interval between the periods. One measure was taken per hour at each sampling point.

Results

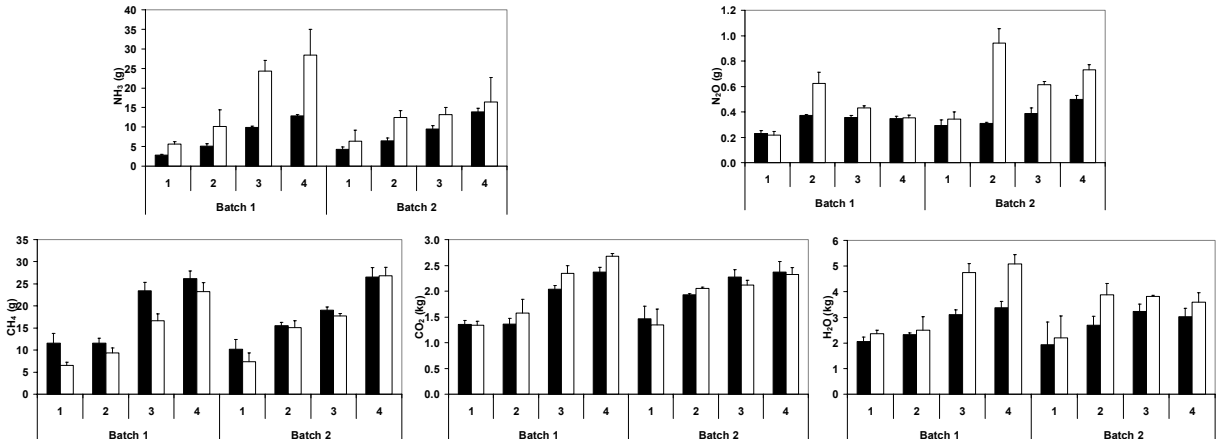
The average temperatures of the air were 20.5 °C in the room with slatted floor and 21.2 °C in the room with deep litter. The mean ventilation rates were 98 and 82 m³/h per pig respectively. The mean initial and final weights of pigs were 26.5 and 112.5 kg. The mean daily weight gain of the pigs raised on slatted floor was significantly higher than that of pigs kept on straw (758 *vs.* 699 g). Table 1 shows the mean emissions observed for the two batches. The evolutions of the gaseous emissions during the fattening period are presented in figure 1.

Table 1 - Gas emissions (g per pig per day) during the raising of two batches of fattening pigs kept on slatted-floor (Sl.-fl.) or on straw deep litter.

	Batch 1				**Batch 2**				**Batches 1 and 2**			
	Sl.-fl.	Straw	s.e.	S.	Sl.-fl.	Straw	s.e.	S.	Sl.-fl.	Straw	s.e.	S.
NH_3	7,91	16,91	0,61	***	8,43	12,18	0,40	***	8,06	14,56	0,39	***
N_2O	0,33	0,41	0,01	***	0,37	0,65	0,01	***	0,35	0,53	0,01	***
CH_4	18,18	13,94	0,29	***	17,84	16,70	0,26	**	18,00	15,34	0,22	***
CO_2	1850	1988	33,61	***	2014	1954	35,63	NS	1927	1974	26,21	NS
H_2O	2713	3672	91,32	**	2725	3366	93,98	**	2714	3522	72,19	***

s.e. : mean standard error; S. : Level of Significance : ** P<0.01, *** P<0.001, NS = nonsignificant

Figure 5 – Evolution of gas emissions (per pig per day) during the raising of two batches of fattening pigs kept on slatted floor (closed bars) or on straw deep-litter (open bars). Emissions were measured during four periods per batch (mean ± s.d. between the six days of measurements).



Over the two batches altogether, the raising of pigs on straw deep litter produced significantly more NH_3 (+81 %, P<0.001), more N_2O (+50 %, P<0.001), less CH_4 (-15 %, P<0.001) and more H_2O (+30 %, P<0.001). The NH_3, CH_4 and CO_2 emissions increased regularly from the

beginning to the end of each fattening period whatever the floor type. H_2O emissions increased during the first half of the fattening periods and then remained stable. There were few variations in the emission of N_2O from the slurry during the 2 fattening periods and the emissions from the deep litter were irregular.

Discussion

NH_3 emission is considered as a key factor to evaluate the environmental performance of intensive livestock farming. In a reference document on best available techniques for intensive rearing of poultry and pigs published by the European Commission, reference levels of NH_3 emission were proposed in order to judge the environmental performances of different housing systems. For fattening pigs the reference housing system includes a fully slatted floor with an underlying deep collection pit. With this system the NH_3 emissions vary between 2.39-to 3.0-kg/pig place (European Commission, 2003). The mean value obtained during this experiment, i.e. 8.06 g/day per pig or 2.66 kg per year (330 occupation days), is in accordance with the reference values. There are in the literature less data concerning NH_3 emissions from deep litter systems. The mean value obtained in this experiment, i.e. 14.56 g/pig per day, is however in concordance with previous results (Nicks et al., 2004). Few experiments have compared in standardized conditions NH_3 emissions in the raising of pigs either on deep litter or on slatted floor. Kermarrec (1999) showed a reduction of 50% of the emissions in the raising of pigs on sawdust-based litters compared to that when pigs are kept on slatted floors. NH_3 emissions from sawdust-based deep litters are however lower than that from straw-based deep litters (Nicks et al., 2003, 2004a) and, when weaned pigs were raised either on a fully slatted floor (plastic panels with a void percentage of 37%) or on a straw-based deep litter the emission from the deep litter was 95% higher than that from the slurry (Nicks et al., 2004b). Straw-based deep litters seem thus to produce more NH_3 than slurry.

N_2O emissions from slurry are often considered as negligible. Kermarrec (1999) reported however an emission of 0.75 g per pig per day, a value higher than the 0.35 g observed in this experiment. N_2O emissions from deep litters are irregular (Nicks et al., 2003, 2004a). In this experiment the mean emission during the stay of the second batch was 58% higher than that observed during the stay of the first batch (0.65 vs. 0.41 g/pig per day). These two means were higher than values observed in a previous experiment which were lower than 0.1 /pig per day (Nicks et al., 2004a).

The higher N losses from the litter compared with the slurry, in the form of N-NH_3 and N-N_2O, contribute to differences in the N contents of the manure, which were respectively of

1.83 kg/pig in the deep litter, and 3.22 kg in the slurry. The difference in the N content of the deep litter and the slurry was however greater than the difference in NH_3 and N_2O emissions. This means that the deep litter lost also N in the form of N_2.

CH_4 emissions come directly from the digestive tract of animals and from the anaerobic decomposition of wastes. The mean value observed in the room with the slatted floor (18 g/pig per day) is in the same order of magnitude as values observed by other authors (Godbout et al., 2003) but higher values have also been reported (Anderson et al., 1987). The mean value observed in the room with the straw-based deep litter (15.34 g/pig per day) is higher than that reported in another experiment (Nicks et al., 2004a). Nevertheless, despite a relatively high emission level in this experiment, the emission from the straw-based deep litter was significantly lower than that of the slurry. However, as the warming potential of N_2O is about 13 times higher than that of CH_4, the cumulative warming potentials of the 2 systems were not significantly different.

As CO_2 originates principally from the respiration of the animals it is not surprising that no significant difference was observed with regard to floor systems. The mean emission was 1.95 kg/pig per day.

Conclusion

The main differences concerning the environmental effects of rearing fattening pigs either on slatted floor or on straw-based deep litter are: higher NH_3 emissions from deep litter pens but a lower N content of the deep litter compared with the slurry.

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