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Influence of permanent use of feeding stalls as living area on ammonia and greenhouse gas emissions for group-housed gestating sows kept on straw deep-litter

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ABSTRACT

In pig production, the interest for litter systems in relation with animal welfare and the ban by 2013 in the EU of individual accommodations for gestating sows could promote the group-housing of gestating sows on deep-litter. However, compared to slatted-floor systems, few data are available on the gaseous emissions associated with the different modalities of rearing sows on deep-litter. In this study, two modalities were compared: group housing on a 3 m^2/sow deep-litter or on a 1.8 m^2/sow deep-litter plus 1.2 m^2/sow concrete floor. In both cases, sows were fed in individual feeding stalls (1.2 m^2/stall) but the access was limited at feeding time in the first case and permanent in the second one.

Three successive batches of 10 gestating sows were used. Each batch was divided into 2 homogeneous groups randomly allocated to one of two treatments: fully (3 m^2/sow) or partly (1.8 m^2/sow) straw-based deep-bedded floor. The groups were kept separately in two identical rooms with same volume and same surface, equipped with five individual feeding stalls in contact with a pen of either 9 or 15 m^2 deep-litter. The feeding stalls were equipped with front feeding troughs and rear gates allowing or not permanent access to the stalls outside of feeding times. Between each batch, the pens were cleaned. In both rooms, ventilation was automatically adapted to maintain a constant ambient temperature. The gas emissions (nitrous oxide, methane, carbon dioxide, ammonia and water vapour) were measured 3 times (weeks 2, 5 and 8 of stay) during 6 consecutive days by infrared photoacoustic detection.

Sow performance was not significantly affected by floor type. With sows kept on partly bedded floor, gaseous emissions were significantly greater for methane (12.76 vs. 9.90 g/d.sow; $P<0.001$), carbon dioxide (3.12 vs. 2.90 kg/d.sow; $P<0.01$) and water vapour (4.70 vs. 4.03 kg/d.sow; $P<0.001$), and significantly lower for nitrous oxide (3.14 vs. 6.12 g/d.sow; $P<0.001$) and CO_2 equivalents (1.24 vs. 2.10 kg/d.sow; $P<0.001$) compared to sows housed on fully bedded floor. There was no significant difference for ammonia emissions (8.36 vs. 7.45 g/d.sow; $P>0.05$).

From the present trial in experimental rooms, it can be concluded that keeping group-housed gestating sows on partly straw bedded floor with permanent access to the concrete feeding stalls compared to fully straw bedded floor did not significantly influence animal performance and NH_3-emissions, and decreased CO_{2eq}-emissions (−40%). This decrease was observed owing to an important decrease of N_2O-emissions (−49%).

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1. Introduction

Compared with slatted-floor systems, litter systems in pig production present advantages in terms of animal welfare improvements (Tuyttens, 2005), odour nuisance reduction (Kaufmann, 1997) and a better perception by the consumers and the neighbours (Chevrant-Breton and Daridan, 2003). Litter systems are however associated with increased production costs related to the use of straw and to the labour for litter management (Nicks, 2004). Furthermore, gaseous emissions from deep litter systems have been little studied compared with slatted-floor systems.

Whatever the floor type, the EU legislation imposes, by 2013, to keep gestating sows in groups from at least 4 weeks after insemination until 1 week before farrowing with a minimum floor area per sow of 2.25 $m^2 \pm 10\%$ according to the size of the group (Directive 2001/88/CE). The directive also specifies that group-housed sows have to be fed using a system which ensures that each individual can obtain sufficient feed even when competitors for the feed are present. One option to satisfy this rule is the use of individual feeding stalls with rear gates allowing sows to be undisturbed during the feeding times. Outside of feeding times, if the rear gates are continually kept open, the permanent access to these feeding stalls can thus be considered as living area. Taking into account this area for calculating the legal available surface is debated in some countries. Compared with a system where the rear gates of feeding stalls would be continually kept closed outside of feeding times, this system allows reducing the construction or renovation costs of pig buildings (due to the reduced need for surface area).

If a permanent access to the feeding stalls is associated with a deep litter system, the living area of the sows can be considered as a partly bedded floor subdivided into a deep litter floor and a concrete floor. This subdivision could influence sows performance and environmental parameters such as gaseous emissions (ammonia (NH_3) and greenhouse gases (GHG)).

NH_3-emissions contribute to soil and water acidification and eutrophication and to indirect emissions of nitrous oxide (N_2O) (Intergovernmental Panel on Climate Change (IPCC, 2006)). Furthermore, NH_3 is a well-known toxic gas, irritating the respiratory tract at concentrations exceeding 15 ppm (Banhazi et al., 2008). According to Reidy et al. (2009), more than 80% of the total NH_3 emissions come from agriculture. In Europe, pig production represents nearby 25% of the livestock emissions (European Environment Agency, 2010). Releases from buildings are the main source, accounting for about 50% of pig NH_3 (Philippe et al., 2011a).

The GHG associated with livestock production are carbon dioxide (CO_2), methane (CH_4) and N_2O. Among these gases, N_2O also contributes to the destruction of the ozone layer. N_2O and CH_4 are important contributors because their global warming potential (GWP) over a 100-year period are 298 and 25 times that of CO_2 (IPCC, 2007), respectively. For CO_2, it is assumed that emissions due to feed utilization by animals are compensated by consumption by photosynthesis of plants used as feed (IPCC, 2007). However, CO_2 as well as H_2O emissions in the building may differ between rearing systems as shown by example for weaning and fattening pigs (Cabaraux et al., 2009; Philippe et al., 2007a, 2007b). Besides, CO_2 and H_2O emissions are key parameters in specifying ventilation rates in order to avoid excessive concentrations in livestock buildings, especially for water vapour with bedded systems (CIGR, 2002; Banhazi et al., 2008).

Therefore, the aim of this study was thus to evaluate the impact of a partly bedded floor for group-housed gestating sows on gaseous emissions (NH_3, N_2O, CH_4, CO_2 and H_2O) compared to fully bedded floor.

2. Material and methods

The trial was carried out in experimental rooms located at the Faculty of Veterinary Medicine of Liège University (Belgium). The ethical committee of the university approved the use and treatment of animals in this study.

2.1. Experimental rooms

Two experimental rooms, similar in volume (103 m^3) and surface (30.2 m^2), were arranged and equipped for this experiment. Rooms consisted of a service area and a pen designed to group-house five gestating sows on deep-litter either on a partly bedded floor (PBF) or on a fully bedded floor (FBF). In the PBF room, the pen consisted of a straw-bedded area (9.0 m^2, i.e. 1.8 m^2 per sow) and five individual feeding stalls (1.2 m^2 per stall) (Fig. 1).

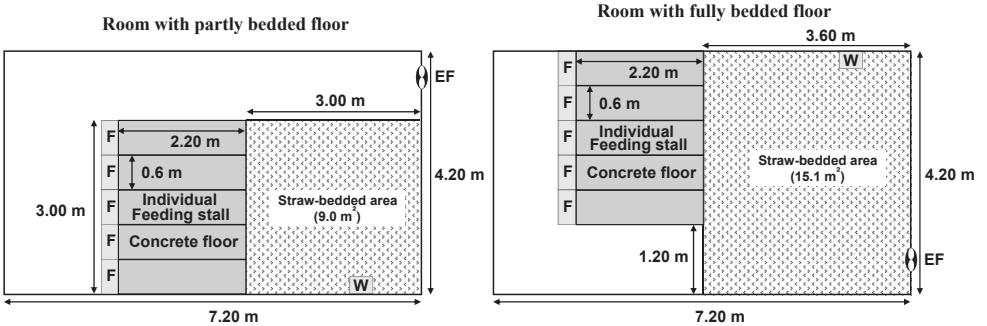

Fig. 1. Design of the experimental rooms.