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Methane production of growing and finishing pigs in southern China

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ABSTRACT

Methane from enteric fermentation and manure decomposition from livestock contributes to greenhouse gas (GHG) emissions. Research on CH_4 production from enteric fermentation has mainly focused on ruminant livestock. However, CH_4 production from enteric fermentation in pigs may be important due to the large global pig population. This experiment measured enteric CH_4 from growing and finishing pigs in China. Five 58.9 ± 1.15 kg and five 89.4 ± 0.85 kg Duroc × Landrace × Large Yorkshire female pigs were randomly selected from a commercial farm in Shenzhen, Guangdong province (China). The pigs were transferred to individual 2.0 m × 1.0 m × 1.2 m respiration chambers located on the same farm and continued to be fed the commercial diets of their respective weight group on the farm. After 3 d of adaptation to the respiration chambers, daily CH_4 emissions were measured from the 10 pigs for 3 d. The CH_4 production of the 60 and 90 kg pigs was 1.13 and 2.01 g pig/d, respectively, with that of 90 kg pigs higher than the 60 kg group ($P<0.05$). When the values are adjusted/kg DM feed intake (*i.e.*, 0.70 g/kg DM *versus* 0.82 g/kg DM) and per kg body weight (19.01 g/kg *versus* 22.47 g/kg) for the 60 and 90 kg groups, there were no differences. Using these values, estimated annual CH_4 production from the 60 and 90 kg pigs was 0.41 kg and 0.73 kg, respectively, values which are lower than the 1 kg pig/year adopted by the Intergovernmental Panel on Climate Change. The high variation in CH_4 emission among our pigs, and those in the literature, suggest that differences in CH_4 emission exist among pigs within the same herd housed under similar nutritional and husbandry management.

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1. Introduction

The contribution of CH_4 gas to greenhouse gas (GHG) emissions is next to CO_2, accounting for 15–20% of total global warming potential (Moss et al., 2000). Methane is the most abundant organic gas in the earth's atmosphere, and its concentrations have increased globally at a rate of about 0.7% during the decade preceding 1994, but has since recorded a small decrease to 2000 (IPCC, 1995). Anthropogenic sources account for about 70% of annual CH_4 production, with enteric fermentation from all domesticated ruminants and animal waste management accounting for ∼16 and 5%, respectively (IPCC,

Abbreviations: BW, body weight; GHG, greenhouse gas; GC, gas chromatograph.

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Table 1
Ingredient (g/kg) and chemical composition of the diets for two weight groups of pigs.

	60 kg	90 kg
Dry corn grain	660	690
Bean meal	230	200
Rapeseed meal	40	40
DDGS[a]	30	30
Premix[b]	40	40
Nutrient contents[c]		
Gross energy (MJ/kg)	13.81	13.39
NDF(mg/g)	179.7	162.3
ADF (mg/g)	79.9	70.4
Crude protein (mg/g)	170	161
Lysine (mg/g)	8.7	8.4
Met + Cys (mg/g)	5.4	5.1
Calcium (mg/g)	6.0	5.3
Phosphorus (mg/g)	5.0	4.5
Available phosphorus (mg/g)	2.4	1.9

[a] Soluble distiller's dried grains.
[b] Commercial premix consists of trace elements (*i.e.*, Fe, Cu, Zn, Mn, I, and Se), vitamins (*i.e.*, A, D, K, E, B1, B2, B6, B12, C, folic acid, and biotin), amino acids (*i.e.*, lysine, and methionine), Ca, P and salts.
[c] Nutrient contents for the respective diets were provided by the farm (see Section 2.1).

1995). A major source of atmospheric CH_4 is agricultural activities involving rice, cattle and other domestic animal farming (Khalil and Rasmussen, 1994). Livestock farming has been the largest anthropogenic source of global CH_4 since 1983 and contributed 113.1 Tg CH_4 in 1994 (Stern and Kaufman, 1996, 2005).

In China, CH_4 emission from livestock enteric fermentation was estimated to be 3.04 Tg in 1949 and increased to 10.13 Tg in 2003, with an annual growth rate of 2.2% (Zhou et al., 2007). All non-dairy livestock accounted for 60% of the total livestock emission in 1949 and 53% in 2003. Based on method and emission rates available in the China Climate Change Country Study (CCCCS, 1999), CH_4 emissions (*i.e.*, enteric fermentation, manure contributions) from sheep, goats and pigs were estimated to increase from 5.80 Tg in 1990 to 8.55 Tg in 2000 (Streets et al., 2001), primarily due to increased numbers.

In 2006, China had 511 million pigs, accounting for 52% of the world pig population (China Animal Agriculture Association, 2008). Due to this large population, information regarding enteric CH_4 emissions from pigs in China is important for estimation of GHG emissions from animal agriculture in China.

Estimates of CH_4 production by ruminants are abundant and based on models arising from data of measurements with confined animals in respiration chambers (Johnson and Johnson, 1995; Takahashi et al., 1999; Islam et al., 2000). However, only a few studies have estimated enteric CH_4 emission from pigs. Studies of Jørgensen (2007) and Jørgensen et al. (2007) were among the few to measure enteric CH_4 production from pigs. These studies primarily focused on effects of fiber sources on the fermentation process and CH_4 production. Although annual CH_4 emission from enteric fermentation from pigs in China was reported to be 0.06 Tg in 1949 and 0.44–0.47 Tg during 1995–2003 (Zhou et al., 2007), these values were estimated based on CH_4 emission rates of pigs that were managed in a manner that was not relevant to the Chinese pig production. We do not know of any published CH_4 emission rates of pigs measured through experimentation in China.

Our aim was to quantify CH_4 emissions from grower and finisher pigs to provide information on their CH_4 emission rates. The study was conducted using pigs from a commercial farm fed in two specific body weight (BW) groups. This approach enabled derivation of CH_4 emission estimates that were relevant to contemporary Chinese pig production systems.

2. Materials and methods

2.1. Animals and feeding

Five 58.9 ± 1.15 kg and five 89.4 ± 0.85 kg Duroc × Landrace × Large Yorkshire female pigs were used, with the 5 pigs within each weight considered as replicates. The pigs were individually housed in open circuit respiration cages and fed the same commercial diet as their respective weight group in the farm twice daily at 07:00 and 19:00 h. The composition and nutrient content of the experimental diets (Table 1) were provided by the farm. The study consisted of 4 d of adaptation and 3 d of CH_4 measurement. During the study, the temperature and relative humidity recorded at 20 min intervals over 3 d inside the chambers were 23.7 ± 3.74 °C and 96 ± 1.6%. Pigs were weighed on day 1 and day 7 of the study period.

2.2. Design of the respiration chambers

Ten respiration chambers were constructed. Each was 2.0 m long × 1.0 m wide × 1.2 m high and constructed using a metal frame covered with transparent poly methyl methacrylate sheets except for the bottom which was made of steel (Fig. 1). Each chamber was wide enough for the pig to stand or lie down freely, but not to turn around. Each chamber was fitted with two windows, one at the front and the other behind, to facilitate feeding and removal of feces, respectively. Urine was