Total tract digestibility of nitrogen in pigs exposed to high environmental temperatures

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ABSTRACT: The effect of environmental heat stress on N metabolism was studied using 7 gilts (50.5 ± 1.7 kg initial BW). Pigs were housed in metabolism cages in a climate-controlled room. After a 4-d adaptation, two 14-d experimental periods followed during which the animals were exposed to thermo-neutral temperature (NT; 20.6 ± 0.1°C) or high environmental temperature (HT; 30.4 ± 0.4°C). In each experimental period, two 24-h balance periods were carried out to collect feces and urine (via bladder catheters) for N analysis. Based on N intake and N excretion, N balance was calculated. At HT conditions, N intake was lower (P = 0.028), urinary N excretion increased (P = 0.040), and N retention decreased (P = 0.001) in comparison with NT conditions. Exposure of pigs to HT tended to reduce (P = 0.070) digestibility of N as compared to NT conditions. When pigs are exposed long term to continuous HT, N retention decreases presumably due to decreased use of ME during respiration.

Key words: digestibility, heat stress, nitrogen, pig

INTRODUCTION

High environmental temperature (HT) may decrease feed intake and weight gain. Pigs decrease feed intake to reduce thermogenesis and thereby limit heat load (Quiniou et al., 2000). During exposure to high temperature, pigs increase N excretion in urine (Liao and Veum, 1994) and decrease N retention (Ferguson and Gous, 2002), but results are not consistent among studies (Le Dividich et al., 1980). Moreover, effects of heat stress on N digestibility are not clear (Elias and Cline, 1991; Liao and Veum, 1994). The aim of the present study was to estimate effects of HT on N metabolism in pigs.

MATERIAL AND METHODS

All experimental procedures were reviewed and approved by the Animal Care Committee of the Animal Production Research Center. Seven gilts with an initial BW of 50.5 ± 1.7 kg were housed in metabolism cages. After a 4-d adaptation, two 14-d experimental periods followed. During the first period, pigs were housed in a room with an environmental temperature of 20.6 ± 0.1°C. During the second period, the environmental temperature was increased to 30.4 ± 0.4°C.

Pigs were fed twice per day a standard diet (Table 1) in 2 equal meals at a daily amount of 90 g/kg BW^0.75. Water was offered ad libitum. On days 6 and 13 of each experimental period, two 24-h balances were performed to collect urine (via bladder catheters) and feces. Daily feed consumption was recorded. Pigs were weighed weekly. Samples of diets and feces were analyzed for DM and total N and samples of urine for total N according to standard methods (AOAC, 1990). Retention and digestibility of N were calculated based on N excretion in urine and feces and N intake.

The experimental data were subjected to ANOVA using Statgraphic Plus 3.1 software with each of 2 experimental periods for each pig as experimental unit. When treatment effects were significant (P < 0.05) or tended to be different (P < 0.10), means were separated using Fisher’s LSD procedure.

RESULTS

In comparison with thermo-neutral conditions, higher temperature reduced (P = 0.028) daily N intake by 4% due to increased feed refusals (Table 2). Daily urinary N excretion was 18% greater (P = 0.040) in
pigs exposed to HT, but N excretion in feces was not affected \((P = 0.180)\) by environmental temperature. Nitrogen digestibility tended to decrease \((P = 0.070)\) and N retention was 20.6% lower \((P = 0.001)\) at high temperature compared to thermo-neutral temperature (NT) (Table 1; Figure 1).

**DISCUSSION**

Nitrogen excretion in feces was not affected by ambient temperatures and N digestibility tended to be lower at high temperature. Similarly, Liao and Veum (1994) reported that N excretion in feces and digestibility of N was unchanged in sows housed at constant high temperatures instead of NT. In contrast, Elias and Cline (1991) reported lower digestibility of N in pigs exposed to high temperature. These conflicting results may be due to the used categories of pigs, which may differ in BW and reaction to heat stress (Quiniou et al., 2000). Another factor responsible for changing protein digestibility at different temperatures is type of diet. The practical type of diets with highly digestible protein may attenuate effects of high temperature on protein digestibility (Bonnet et al., 1997).

In our experiment, N retention was lower at high temperature. Similarly, Ferguson and Gous (2002) reported lower N retention in young pigs housed at 30°C in comparison with 20 and 25°C, similar to a 23% reduced protein retention when temperature increased from 23 to 33°C (Collin et al., 2001). The decrease in N use might be related to a decreased use of ME when the ambient temperature exceeds the upper critical temperature (Elias and Cline, 1991) because expenditure of energy during respiration is increased (Ingram and Legge, 1969). The upper critical temperature is the temperature at which respiratory rate is maximized and further increase in ambient temperature will result in an uncontrolled rise of body temperature.

A higher N excretion in urine in pigs exposed to high temperatures indicates an increased N degradation and AA catabolism (Elias and Cline, 1991) for the purpose of thermoregulation. In contrast, Le Dividich et al. (1980) did not observe differences in N retention between pigs housed at 20 and 28°C. Nitrogen metabolism might therefore be influenced only by temperatures that are either too high (Holmes, 1973; Liao and Veum, 1994; Ferguson and Gous, 2002) or too low (Close and Mount, 1978). In conclusion, N retention in pigs decreases at HT presumably due to increased energy expenditure during respiration.

**LITERATURE CITED**


