Carcass Composition of Market Weight Pigs Subjected to Heat Stress *in utero* or during Growth

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Summary and Implications

Pigs were exposed to prolonged chronic heat stress (HS) and thermoneutral (TN) conditions prenatally (during first of last half of gestation) or postnatally (7-10 wk starting at 14 wk of age). Gestational HS had minimal impact on carcass composition but may impact skeletal system structure and development. Additionally, results indicate that while similar levels of lean can be achieved in pigs subjected to chronic postnatal HS with increased time on feed, carcass fat may be decreased with HS.

Introduction

Ambient temperatures above thermal comfort zones drastically reduce livestock performance. It is estimated that HS costs the livestock industry approximately $2 billion per year in the U.S., and the U.S. swine industry loses over $300 million annually. Subcutaneous adipose tissue and a lack of functional sweat glands intensify HS susceptibility of swine.

The objective of this study was to investigate the effects of prolonged gestational or direct HS on performance and carcass composition of market weight pigs. It was hypothesized that prenatal HS would impact postnatal performance and carcass traits, including lean and fat deposition. Additionally, direct postnatal HS should result in reduced performance, including less carcass lean and greater adiposity.

Materials and Methods

Pregnant sows at the University of Missouri were exposed to either thermoneutral (TN, 18 to 22 °C) or heat stress (HS, 28 to 34 °C) conditions. Four gestational treatments were utilized. TNTN and HSHS were exposed to TN or HS conditions during the entire gestation, respectively. HSTN and TNHS treatments were heat stressed for the first or second half of gestation, respectively. After parturition, sows and their litters were moved to TN conditions.

Barrows from each gestational group (n = 5 to 7 per gestational/direct treatment combination; total of 48 pigs) were weaned at 3 wk of age and transported to Iowa State University. At 11 wk, pigs were moved to individual pens with ad libitum access to water and feed. Starting at 14 wk of age, pigs were exposed to either TN (21 °C, 35-50 % humidity) or HS (35 °C, 24-43 % humidity) conditions for the duration of the study. Body weight (BW) and feed intake data were recorded weekly, and body temperature parameters (rectal temperature; skin temperature; respiration rate) were monitored twice weekly for 5 wk.

Barrows were kept in HS or TN conditions until slaughter at 21 to 24 wk of age. Pigs were divided into four equal slaughter groups based on BW, and slaughtered at the Loeffel Meat Laboratory at the University of Nebraska-Lincoln. One side of each post-rigor carcass was transported to the Iowa State University Meat Laboratory for dissection.

Organ weights, including head, heart, liver, kidney, spleen, and leaf fat, were collected during slaughter. Loin eye area and backfat thickness were measured at the tenth rib of each side just before fabrication. Sides were then separated into lean (approximately 90% lean), adipose, bone, and skin tissue components and weighed. Additionally, proximate analyses were performed on a sample of the longissimus muscle (LD) removed at the 10th rib to determine percent moisture, protein, and lipid.

Results were analyzed using PROC MIXED of SAS v. 9.2.

Results and Discussion

Gestational HS (GHS) did not result in significant differences in postnatal performance or body temperature attributes. Pigs subjected to the HS treatment during postnatal growth had a decreased rate of gain compared to TN pigs (**Figure 1**).

Carcass characteristics are shown in **Table 1.** GHS resulted in decreased head size and percent bone, which may be an effect of retardation of growth at specific developmental stages during gestation. Decreased head size may partially explain increased dressing percent of GHS carcasses. Percent skin was also decreased with GHS, which could be a mechanism by which GHS animals attempt to prevent postnatal overheating. No other significant carcass differences were observed with GHS.

BW and HCW were decreased with postnatal HS. Additionally, it took 1-3 weeks longer for HS barrows to reach BW endpoints observed in this study compared to TN barrows. Cooler shrink was increased, however, which may be due to greater moisture in muscle from HS carcasses, demonstrated by LD proximate analysis (**Table 2**). HS barrows had less backfat, as well as total adipose tissue

compared to TN barrows. However, LD intramuscular fat did not differ between the two groups. HS barrows also had smaller hearts, livers, and kidneys, and a greater percent bone than TN pigs. Percent lean tissue was increased in HS pigs. However, total lean did not differ, and loin eye area was not different between the two groups.

Acknowledgments

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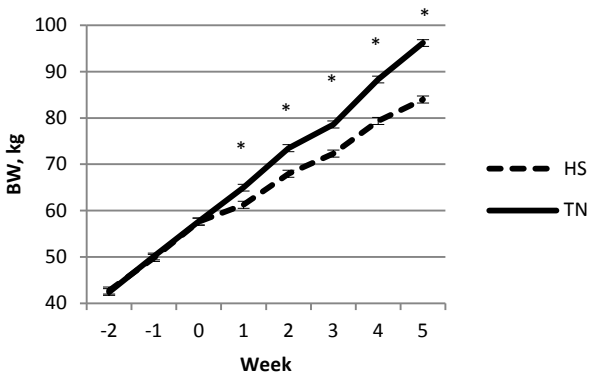

Figure 1. Body weights of pigs during 5 wk of constant heat stress (HS) or thermoneutral (TN) conditions. *Indicates significant differences (P < 0.05).

Table 1. Carcass composition of barrows subjected to heat stress (HS) and thermoneutral (TN) conditions during gestation or finishing. Values with different superscripts differ (P < 0.05).

	Gestation Effects					Finishing Effects		
	HSHS	HSTN	TNHS	TNTN	P-value	HS	TN	P-value
BW, kg	110.2 ± 1.1	109.5 ± 1.2	107.9 ± 1.1	107.8 ± 1.2	0.35	105.8 ± 0.8	111.9 ± 0.8	<0.0001
HCW, kg	86.8 ± 0.9	85.4 ± 1.0	84.0 ± 0.9	83.5± 1.0	0.08	82.7 ± 0.7	87.1 ± 0.7	<0.0001
Dressing Percent, %	78.69^{a} ± 0.24	77.95^{ab} ± 0.26	77.84^{ab} ± 0.24	77.47^{b} ± 0.26	<0.01	78.16 ± 0.18	77.81 ± 0.17	0.17
Cooler Shrink, %	2.90 ± 0.19	3.02 ± 0.20	2.65 ± 0.19	3.04 ± 0.20	0.47	3.08 ± 0.14	2.73 ± 0.14	0.08
Head, % BW	4.99^{b} ± 0.09	5.23^{ab} ± 0.10	5.39^{a} ± 0.09	5.40^{a} ± 0.10	<0.01	5.37 ± 0.07	5.14 ± 0.07	0.02
Liver, % BW	1.33 ± 0.03	1.39 ± 0.03	1.36 ± 0.03	1.31 ± 0.03	0.51	1.31 ± 0.02	1.41 ± 0.02	<0.01
Heart, % BW	0.39 ± 0.01	0.38 ± 0.01	0.37 ± 0.01	0.40 ± 0.01	0.50	0.37 ± 0.01	0.41 0.01	<0.01
Kidney, % BW	0.34 ± 0.009	0.33 ± 0.010	0.34 ± 0.009	0.34 ± 0.010	0.89	0.32 ± 0.006	0.36 ± 0.005	0.0001
Spleen, % BW	0.16 ± 0.006	0.15 ± 0.007	0.15 ± 0.006	0.16 ± 0.007	0.71	0.15 ± 0.005	0.16 ± 0.004	0.60
Leaf Fat, % BW	1.16 ± 0.08	1.34 ± 0.08	1.13 ± 0.08	1.07 ± 0.08	0.14	1.18 ± 0.06	1.17 ± 0.06	0.94
Lean, % BW	25.27 ± 0.29	24.96 ± 0.32	24.29 ± 0.29	24.86 ± 0.32	0.14	25.28 ± 0.22	24.42 ± 0.21	<0.01
Adipose, % BW	4.66 ± 0.33	4.74 ± 0.36	5.12 ± 0.33	4.25 ± 0.36	0.37	3.96 ± 0.25	5.43 ± 0.24	0.0001
Bone, % BW	4.52^{ab} ± 0.10	4.64^{ab} ± 0.10	4.38^{b} ± 0.10	4.78^{a} ± 0.10	0.04	4.79 ± 0.07	4.38 ± 0.07	<0.001
Skin, % BW	2.70^{b} ± 0.08	2.57^{b} ± 0.08	2.92^{a} ± 0.08	2.77^{ab} ± 0.08	0.03	2.82 ± 0.06	2.67 ± 0.06	0.07
Backfat, cm	2.36 ± 0.14	2.25 ± 0.16	2.39 ± 0.14	2.25 ± 0.16	0.87	2.06 ± 0.11	2.57 ± 0.10	<0.01
LEA, cm^2	51.0 ± 1.4	48.0 ± 1.5	48.6 ± 1.4	47.1 ± 1.5	0.27	49.3 ± 1.1	48.1 ± 1.0	0.42

Table 2. Proximate composition of longissimus muscle in barrows subjected to heat stress (HS) and thermoneutral (TN) conditions during gestation or finishing. Values with different superscripts differ (P < 0.05).

	Gestation Effects					Finishing Effects		
	HSHS	HSTN	TNHS	TNTN	P-value	HS	TN	P-value
% Moisture	73.39 ± 0.15	73.42 ± 0.16	73.75 ± 0.15	73.71 ± 0.15	0.20	73.87 ± 0.11	73.26 ± 0.11	<0.001
% Protein	23.41 ± 0.14	23.39 ± 0.15	23.16 ± 0.14	23.24 ± 0.15	0.55	23.10 ± 0.10	23.49 ± 0.10	0.01
% Lipid	2.04 ± 0.26	1.75 ± 0.28	1.64 ± 0.26	1.67 ± 0.28	0.69	1.60 ± 0.19	1.95 ± 0.19	0.19