2008

Evaluating Finishing Pig Growth During Summer and Winter in Bedded Hoop and confinement Buildings

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Abstract

Finishing pig growth in hoop and confinement buildings during summer and winter was evaluated using serial ultrasound measurements of backfat (BF) thickness, loin muscle area (LMA), and serial weighing. Pigs (16 to 124 kg) were housed in a hoop building (9.1 × 18.3 m) or mechanically ventilated, totally slotted confinement building. Forty-eight pigs from each building were scanned and weighed every 14 d during the last 56 d before market. In summer, BF accretion rates were greater for hoop pigs than confinement pigs 80 to 90 kg ($P < 0.05$), but did not differ 95 to 115 kg. In winter, BF accretion rates were similar 80 to 105 kg, but hoop pigs had less BF accretion 110 and 115 kg ($P < 0.05$). In summer, LMA accretion rates were similar 80, 85, and 100 to 115 kg, but were less for hoop pigs 90 and 95 kg ($P < 0.001$). In winter, the hoop pigs had greater LMA accretion rates 80 to 115 kg ($P < 0.05$). In summer, bodyweight gain was similar 80 to 95 kg, and was greater for hoop pigs 100 to 115 kg ($P < 0.05$). In winter, bodyweight gain was similar 100 to 115 kg, but was less for hoop pigs 80 to 95 kg ($P < 0.05$). Finishing pig growth is dependent on thermal environment. Hoop-reared pigs (particularly in winter) may compensate for an early lag with faster muscle growth and slower fat deposition later in finishing.

Keywords

Alternative swine housing systems, Finishing pigs, Pig growth

Disciplines

Agriculture | Animal Sciences | Bioresource and Agricultural Engineering

Comments

This article is from *Applied Engineering in Agriculture* 24, no. 1 (2008): 79–85.

EVALUATING FINISHING PIG GROWTH DURING SUMMER AND WINTER IN BEDDED HOOP AND CONFINEMENT BUILDINGS

J. R. Morrical, M. S. Honeyman, J. D. Harmon, T. J. Baas, C. R. Schwab

ABSTRACT. *Finishing pig growth in hoop and confinement buildings during summer and winter was evaluated using serial ultrasound measurements of backfat (BF) thickness, loin muscle area (LMA), and serial weighing. Pigs (16 to 124 kg) were housed in a hoop building (9.1 × 18.3 m) or mechanically ventilated, totally slotted confinement building. Forty-eight pigs from each building were scanned and weighed every 14 d during the last 56 d before market. In summer, BF accretion rates were greater for hoop pigs than confinement pigs 80 to 90 kg (P < 0.05), but did not differ 95 to 115 kg. In winter, BF accretion rates were similar 80 to 105 kg, but hoop pigs had less BF accretion 110 and 115 kg (P < 0.05). In summer, LMA accretion rates were similar 80, 85, and 100 to 115 kg, but were less for hoop pigs 90 and 95 kg (P < 0.001). In winter, the hoop pigs had greater LMA accretion rates 80 to 115 kg (P < 0.05). In summer, bodyweight gain was similar 80 to 95 kg, and was greater for hoop pigs 100 to 115 kg (P < 0.05). In winter, bodyweight gain was similar 100 to 115 kg, but was less for hoop pigs 80 to 95 kg (P < 0.05). Finishing pig growth is dependent on thermal environment. Hoop-reared pigs (particularly in winter) may compensate for an early lag with faster muscle growth and slower fat deposition later in finishing.*

Keywords. *Alternative swine housing systems, Finishing pigs, Pig growth.*

Due to increased pressure from environmental, community, and animal welfare interests, alternatives to confinement pig finishing systems have received interest in the last decade. One alternative being adopted is hoop buildings (Honeyman et al., 2001b). Hoop buildings are Quonset shaped, with a tarp pulled tightly over trusses and attached to sidewalls. Pigs are kept inside the structure and most of the floor is covered with bedding (MWPS, 2004). Waterers and feeders are placed on a concrete pad.

Gadd (1993) documented the use of tunnel housing in Japan for finishing pigs, and researchers in Canada adapted this technology into the hoop building. Canadian finishing pig performance was documented by Connor (1993, 1994, 1997) and was similar to pigs finished in confinement. Honeyman and Harmon (2003) indicated that pigs reared in hoop and confinement buildings performed similarly, with seasonal variations for pigs in the hoop building.

Real-time ultrasound has been an accurate technology to predict carcass composition since the early 1990s (Moeller, 2002). Serial ultrasound imaging (repeated measurements of the same animal over a period of time) has been used to better understand swine growth and development, particularly backfat (BF) and loin muscle (LM) accretion rates. As pigs reach the point of inflection on their growth curve, protein accretion rates decline and fat deposition rates increase (Whittemore, 1998). Rearing environment influences the ability of pigs to maximize protein accretion (Moughan et al., 1995).

Growth and development of pigs has been extensively studied; however, comparisons between alternative building systems have not been widely made. The objective of this study is to evaluate the effects of season and building type on growth and development of finishing pigs. By obtaining serial weight and ultrasound measurements, comparisons of weight gain, as well as BF and LM accretion, can be made between hoop- and confinement-reared pigs in summer and winter.

METHODS

In this study, pigs reared in a hoop building or conventional confinement finisher building were weighed, and backfat and loin muscle area measurements were taken using real-time ultrasound five times during the finishing phase. These data were used to evaluate environmental effects on growth and on the deposition of loin muscle and backfat of pigs reared in the two housing systems. All pigs were finished at the Hoop Research Complex at the ISU Rhodes Research Farm near Rhodes, Iowa. Animal housing and care was conducted under the supervision of the Iowa State University Committee on Animal Care log no. 1-8-3774-1-S, and in accordance with the *Guide for the Care and Use for Agricultural Animals in Agricultural Research and Teaching* (FASS, 1999).

Submitted for review in July 2007 as manuscript number SE 7113; approved for publication by the Structures & Environment Division of ASABE in November 2007.

Mention of company or product names is for presentation clarity and does not imply endorsement by the authors or Iowa State University, nor the exclusion of any other products that may be suitable for application.

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  ISSN 0883-8542

Animals

All pigs for the experiment were from terminal Duroc boars crossed with predominantly white sows. Pigs were regarded as having a high health status and showed no clinical signs of infectious disease. The groups consisted of approximately half barrows and half gilts, and weaning groups were randomly assigned to housing systems. Pigs entering a building were all weaned within a one-week time period, entered the two buildings types weighing 16 kg, and were marketed at 124 kg (Honeyman and Harmon, 2003). In the summer (April through August, 2000), 152 pigs were placed in the hoop building and 22 pigs were placed in each of the six confinement pens. There were 141 pigs marketed from the hoop building and 127 pigs marketed from the confinement building. In the winter (October 2000 through February 2001), 154 pigs were placed in the hoop building and 22 pigs were placed in each of the six confinement pens. There were 140 pigs marketed from the hoop building and 127 pigs marketed from the confinement building.

Pigs were harvested at a commercial packing plant (Excel Corp., Ottumwa, Iowa). Marketing began when the pigs in a building attained an average weight of 109 kg. There were two marketings for each building. On the first marketing, all pigs weighing 109 kg or more were marketed. All pigs less than 109 kg remained in the building until the average weight in the building was 107 kg; all pigs were then marketed out of the building. Only marketed pigs were included in the analysis. Sick or injured pigs that were deemed unable to recover were euthanized by captive bolt. Pigs were culled based on conditions that would make them unacceptable to the packer (i.e., umbilical hernia, rectal prolapse, lameness) and were marketed alternatively (Honeyman and Harmon, 2003). Light pigs that weighed less than 100 kg bodyweight were still marketed at the packing plant. Mortalities, culls, and light pigs were excluded from the study. The percentage of mortalities, culls, and light pigs was similar for each building type and season.

Weigh and Scanning

Pigs were scanned and images were analyzed by a National Swine Improvement Federation certified ultrasound technician. The ultrasound machine used was an Aloka 500 V SSD ultrasound machine (Wallingford, Conn.) fitted with a 3.5-MHz, 12.5-cm linear array transducer. Ninety-six pigs were randomly selected from the hoop building (48 pigs) and also from the confinement building (48 pigs) for serial scanning in each season.

Pigs selected at the beginning of the trial for the serial scan portion of the experiment were weighed and scanned five times at approximately 14-d intervals the last 56 d of finishing. However, some pigs were not weighed and/or scanned all five times. Weigh/scan period 2 for winter confinement pigs and weigh/scan period 3 for winter hoop pigs were unavailable for recording due to inclement weather. Lean gain was calculated with a formula from NPPC (2000) that uses body weight, backfat thickness, and loin muscle area.

Housing

For this experiment one hoop building and one completely slotted, mechanically ventilated confinement building were used. The 9.1- × 18.3-m hoop building was designed to hold approximately 150 pigs in one large pen. The confinement building had six pens that housed 22 pigs each. Each pen had an area of 4.1 × 4.0 m (Honeyman and Harmon, 2003).

The hoop building was operated as an open-air, unheated structure, and large round bales of cornstalks were used for bedding. Bales were unrolled in the hoop building to create a layer of bedding about 22 cm thick. Several additional bales were unwrapped and placed on end before pigs were placed in the building. Bedding was added as needed to maintain a dry bedding pack. During winter, the north end of the building was closed except for a vent at the top to prevent condensation inside the building. In summer, both ends of the hoop building were open and a temperature-activated sprinkler system was operated on a timer. There was a concrete pad (5.5 × 9.1 m) at the south end of the building where feeders and waterers were placed.

The confinement building was constructed as a pre-fabricated modular finisher. Wall and ceiling insulation was consistent with normal practice. The building had overall dimensions of 4.9 × 26.8 m. The animal room was 4.7 × 23.6 m with a .6-m wide alley along one sidewall. Manure was held in an under-floor pull plug system that was emptied as needed to an outdoor storage tank.

Ventilation was provided using seven quad-style inlets (Double L Group Ltd., C2000, Dyersville, Iowa). Three fans were used to provide negative pressure ventilation. These included the following, all manufactured by Vostermans Ventilation (Bloomington, Ill.) as Multifan: 1) Model PH4E45, rated at 1.45 m^3/s (3090 cfm) at 25 Pa (0.1-in. H_2O) of static pressure; 2) Model PH4E50, rated at 1.87 m^3/s (3960 cfm) at 25 Pa (0.1-in. H_2O) of static pressure; 3) Model PH4E63, rated at 2.49 m^3/s (5280 cfm) at 25 Pa (0.1-in. H_2O) of static pressure.

A Varifan ECS 3M ventilation controller (Monitrol, Quebec, Can.) provided ventilation based on the setpoint temperature. Minimum temperature was set at 24°C when pigs were placed in the building and was reduced 2°C each week until 16°C was reached (Honeyman and Harmon, 2003). Minimum ventilation in winter was set to be approximately 0.32 m^3/s at the start of each group but was adjusted to maintain a relative humidity below 60% as the pigs grew. Other fans were staged on as needed. Heat was supplemented using a propane air heater (L.B. White, Onalaska, Wis.) to maintain a minimum air temperature. The maximum ventilation rate for summer was 5.82 m^3/s or 0.44 m^3/s-pig. Sprinklers were staged on as a means of cooling pigs once ventilation was maximized. The sprinkler system was activated at 32°C and was on a timer (2 min. on, 8 min. off) to reduce heat stress.

Diets and Feeders

All pigs were fed the same five diets in phase ad libitum during the trials according to published nutrient guidelines (NRC, 1998). All diets were corn-soybean meal based and fed in meal form of 650 to 750 microns. Two round feeders with 12 spaces each and two waterers with two spaces each were used in the hoop building. In the confinement building, one round feeder with eight spaces and four nipple waterers were used in each pen (Honeyman and Harmon, 2003). Feed was weighed when placed in feeders. Every 28 d, feeders were weighed and feed disappearance was recorded. Feed wastage was minimized by feeder adjustment, but feed wastage was not measured or estimated.

Data Analysis

Pig body weights (BW) and ultrasound measurements were used at the off-test weigh period to calculate average daily gain (ADG), lean gain on test (LGOT), tenth-rib backfat (BF), and loin muscle area (LMA). Least squares means and corresponding standard errors were calculated using the Proc Mixed procedure from SAS (SAS Inst. Inc., Cary, N.C.). The model for ADG and LGOT contained fixed effects of building, season, and gender, and it also included a linear covariance for on-test weight. The model for BF and LMA included fixed effects of building, season, gender, and a linear covariance for off-test weight. All two-way interactions were included in the full model and all interactions of nonsignificance were eliminated.

Traits measured serially were BF, LMA, and BW. A random regression model was fit to the serial data using SAS to model covariances between repeated records. The model used to evaluate growth patterns of serially measured traits included similar effects for the model described previously of the building and season, along with the addition of fixed and random curves. Interactions of second-order polynomial terms with the building were also fit for the evaluations of BF, LMA, and BW. A first-order polynomial was fit for the random curves of BF, LMA, and BW. An unstructured covariance structure was fit for the random terms and an auto-regressive covariance structure was fit for the residuals. All two-way interactions were evaluated but were not significant and were dropped from the model. Repeated records from scanning and weighing were used for the SAS random regression model. LS means from 80 to 115 kg at 5-kg increments were calculated to develop figures 1-6.

Results

Outdoor temperature records were acquired from the Marshalltown, Iowa weather station for the duration of the trials. Marshalltown is less than 30 km from the research farm. The summer was similar to the long-term (56-year average) temperature. For the summer trial, the average high temperature was 24.7°C and the average low temperature was 11.8°C compared with 24.4°C and 12.1°C for the long-term averages. The winter was colder than normal. For the winter trial the average high temperature was 2.4°C and the average low temperature was -8.3°C compared with the long-term averages of 4.9°C and -6.3°C.

The distribution of pig records by season is shown in table 1. The raw means of the serial pig liveweights for summer and winter are shown in tables 2 and 3, respectively.

Table 1. Distribution of records from a study comparing pigs reared in hoop and confinement buildings in summer and winter.

		No. of Observations			
		Summer		Winter	
Item	Total	Hoop	Confinement	Hoop	Confinement
Trait category					
No. on trial	535	141	127	140	127
Serial measures[a]	181	47	45	44	45
Avg on-test wt (kg)		16.3	16.8	15.9	17.2
Avg off-test wt (kg)		103.7	102.9	126.4	124.3

[a] Serial measures = tenth-rib backfat, loin muscle area, and bodyweight.

Table 2. Means ± (SEM) for serial bodyweight measures of pigs reared in hoop and confinement buildings in summer.

	Hoop		Confinement	
Item	Date	Weight (kg)	Date	Weight (kg)
Weigh 1	6/16/00	54.1 ± (5.9)	6/30/00	55.7 ± (4.6)
Weigh 2	6/30/00	69.1 ± (6.7)	7/14/00	66.5 ± (5.4)
Weigh 3	7/14/00	81.3 ± (7.2)	7/28/00	79.1 ± (7.1)
Weigh 4	7/28/00	91.7 ± (8.3)	8/11/00	90.4 ± (6.6)
Weigh 5	8/11/00	104.8 ± (8.8)	8/25/00	103.5 ± (7.9)

Table 3. Means ± (SEM) for serial bodyweight measures of pigs reared in hoop and confinement buildings in winter.

	Hoop		Confinement	
Item	Date	Weight (kg)	Date	Weight (kg)
Weigh 1	11/21/00	59.4 ± (9.2)	12/05/00	56.0 ± (6.2)
Weigh 2	12/05/00	64.5 ± (6.3)	12/19/00	70.1 ± (7.9)
Weigh 3	12/19/00	80.0 ± (7.0)	1/04/01	84.3 ± (8.6)
Weigh 4	1/04/01	90.5 ± (9.5)	1/18/01	97.0 ± (9.2)
Weigh 5	1/18/01	101.8 ± (8.9)	2/01/01	107.1 ± (9.7)

Table 4. Least squares means ± (SEM) for ultrasonic and growth performance measures of pigs reared in hoop and confinement buildings (summer and winter combined).

Item[a]	Hoop[b]	Confinement
Ultrasonically measured		
BF (mm)	20 ± (2)	21 ± (2)
LM (cm^2)	42.7 ± (0.3)^a	44.6 ± (0.3)^b
Growth performance		
ADG (g/day)	827 ± (4)	824 ± (4)
LGOT (g/day)	336 ± (2)^a	342 ± (2)^b

[a] BF = Tenth-rib backfat; LM = loin muscle area; ADG = average daily gain; LGOT = lean gain on test.
[b] a,b LS means with different superscripts in the same row differ ($P < 0.05$).

Growth Performance

Average daily gain (ADG) did not differ between building type averaged over both seasons ($P > 0.05$) (table 4). Differences ($P < 0.001$) were detected for ADG between summer (802 ± 6 g/d) and winter (844 ± 6 g/d) for the confinement building. This difference may be explained by heat stress caused by warm temperatures in the summer season, which may reduce feed intake and increase the maintenance requirements of the pigs. Pigs in confinement buildings in the winter are more likely to be at a thermally neutral temperature. No difference ($P > 0.05$) between seasons was found for ADG in the hoop building (table 5). There was a difference ($P < 0.05$) for ADG between the hoop building (819 ± 6 g/d) and the confinement building (802 ± 6 g/d) during the summer season (table 5). These results may indicate that hoop pigs have less heat stress than confinement pigs due to the open-air ventilation and their ability to find a cooler microenvironment. There was no difference in ADG between building type for the winter season ($P > 0.05$) (table 5). These results conflict with those reported by Lopez et al. (1991) and Mangold et al. (1967) where pigs reared in cold environments grew more slowly than pigs reared at thermoneutrality. This difference may be due to several reasons. In hoop buildings, pigs have the ability to find a suitable microclimate by burrowing deep into the bedding

Table 5. Least squares means ± (SEM) for ultrasonic and growth performance measures of pigs reared in hoop and confinement buildings in summer and winter.

Item[a]	Summer		Winter	
	Hoop[b]	Confinement	Hoop	Confinement
Ultrasonically measured				
BF (mm)	19.9 ± (0.3)[a,b]	20.3 ± (0.3)[a,b]	19.8 ± (0.3)[b]	20.8 ± (0.3)[a]
LMA (cm^2)	44.3 ± (0.4)[a]	45.0 ± (0.4)[a]	41.1 ± (0.4)[b]	44.1 ± (0.4)[a]
Growth performance				
ADG (g/day)	819 ± (6)[b]	802 ± (6)[c]	832 ± (6)[a,b]	844 ± (6)[a]
LGOT (g/day)	350 ± (2)[a]	345 ± (2)[a]	323 ± (2)[c]	338 ± (3)[b]

[a] BF = tenth-rib backfat; LMA = loin muscle area; ADG = average daily gain; LGOT = lean gain on test.

[b] a,b,c LS means with different superscripts in the same row differ ($P < 0.05$).

pack thereby reducing heat loss by conduction and reducing draft exposure; thus, the effective temperature for the pigs is much closer to thermoneutrality than the ambient temperature (Larson et al., 2003). Honeyman et al. (2001a) reported that the composting bedding pack in the building generated temperatures of 40°C at 15- to 30-cm depths and 30°C over half of the bedding pack area. This decomposition can result in an increase in temperature inside the hoop building of 3.3°C to 4.4°C on the coldest days in winter (Harmon and Xin, 1996), and perhaps even warmer temperatures for the effective zone that the pigs occupy due to a reduction in heat loss from conduction and convection.

Lean gain on test (LGOT) was 6 g/d more in the confinement building over the entire test period ($P < 0.05$) (table 4). Comparing seasons the pigs reared in the confinement building had a LGOT that was 7 g/d more during summer ($P < 0.05$) (table 5). Lean gain on test was 27 g/d more in summer than in winter for the hoop building ($P < 0.001$). In summer, LGOT was higher for confinement-reared pigs (346 ± 55 g/d vs. 338 ± 55 g/d) than hoop-reared pigs ($P < 0.05$). In winter, confinement pigs had LGOT 15 g/d more than pigs in hoop buildings ($P < 0.001$). Average daily gain was not depressed for pigs reared in hoops in the winter, probably because of an increase in feed intake. Small differences in carcass composition, particularly LMA, can affect LGOT (Schwab, 2005). In winter, hoop-reared pigs were leaner, i.e. had less backfat, ($P < 0.05$) but also had smaller LM ($P < 0.001$) than confinement pigs, which may explain why they also had a poorer LGOT (table 5).

Ultrasonically Measured Carcass Composition

Loin muscle area (LMA) difference between building type was 1.9 cm^2 more over the entire trial period for confinement-reared pigs ($P < 0.001$) (table 4). Loin muscle area did not differ between seasons for the confinement building; however, hoop-reared pigs in summer had 3.2 cm^2 larger LMA than in winter ($P < 0.001$). LMA comparisons between buildings by season did not differ in the summer but in the winter, hoop-reared pigs had 3.1 cm^2 smaller LMA than confinement-reared pigs ($P < 0.001$) (table 5). According to Moughan et al. (1995), pigs with the same genotype may have different upper limits of protein deposition (PDmax), depending on environment. The type of housing system may influence the PDmax of pigs housed in it, and the influence may vary, depending on the season.

In the winter, BF between building types was 1 mm less for hoop-reared pigs compared with confinement-reared pigs ($P < 0.05$) (table 5). However the BF between building types did not differ in the summer. Thickness of BF between seasons within building type (hoop and confinement) did not differ (table 5).

Serially Measured Traits

Daily accretion rates and cumulative curves of LMA and BF for hoop-reared and confinement-reared pigs in summer and winter are plotted in figures 1 through 4. Body weight gain/d by BW is plotted in figures 5 and 6. Accretion rates for LMA, BF, and BW for pigs from 80 to 115 kg are shown in table 6. The analysis of the serially measured traits showed that growth, loin muscle, and backfat accretion may be dependent on building type and thermal environment.

There was no difference between hoop- and confinement-reared pigs for cumulative BF thickness measurements from 80- to 115-kg BW in summer or winter (figs. 1 and 2). Comparison of pigs reared in hoop and confinement buildings during summer (fig. 1) illustrates that daily accretion rates are greater for hoop-reared pigs by 0.04, 0.05, and 0.05 mm at 80-, 85-, and 90-kg BW, respectively ($P < 0.05$). There were no differences detected from 95 to 115 kg. At 105 kg, the accretion curves for the two building types cross and confinement-reared pigs began depositing BF at a greater rate than at lighter weights (fig. 1). Although accretion rates do not differ at 115 kg between building type, if the trend continued, at heavier weights some differences would occur and the confinement-reared pigs would accrete BF at a greater rate than the hoop-reared pigs (fig. 1).

Comparison of BF accretion rates in winter for hoop and confinement buildings showed no difference from 80- to 105-kg BW (fig. 2). At 110- and 115-kg BW, accretion rates for confinement-reared pigs were 0.082 and 0.119 mm greater than hoop-reared pigs, respectively ($P < 0.05$) (fig. 2). In both seasons (figs. 1 and 2), the hoop-reared pigs deposited BF at a more constant rate from 80 to 115 kg than the confinement-reared pigs. Confinement pigs tended to deposit less fat at lighter weights and increased the rate of BF deposition as their weight increased. Because the diets of both buildings were the same and hoop pigs generally had a greater average daily feed intake (ADFI) (Honeyman and Harmon, 2003), the hoop-reared pigs in the summer received more metabolizable energy (ME) than the confinement pigs at the same weight. This increase in ME resulted in hoop-reared pigs depositing more BF/d than confinement pigs at 80- to 90-kg BW in summer when their energy need for maintenance was similar to the pigs reared in confinement.

In summer, loin muscle (LM) accretion rates for hoop- and confinement-reared pigs differed at 85- and 105-kg BW ($P < 0.05$). From 90 to 100 kg BW, accretion rates also differed ($P < 0.001$). From 85- to 110-kg BW, confinement-pigs have greater LM accretion rates than hoop-reared pigs. At 80- and 115-kg BW, LM accretion rates are similar. Between those weights, the confinement-reared pig accretion rates increase slightly, and hoop-reared pig accretion rates decrease slightly creating the difference in rates (fig. 3). The difference in accretion rates is probably due to the difference in rearing environment.

Table 6. Least squares means (± SEM) for daily accretion rates of backfat, loin muscle, and bodyweight in relation to body weight for hoop- and confinement-reared pigs in summer and winter.

	Summer		Winter	
Item[a]	Hoop[b]	Confinement	Hoop	Confinement
80 kg				
BF (mm/d)	0.17 ± (0.01)[a]	0.13 ± (0.01)[b]	0.09 ± (0.03)[b]	0.11 ± (0.03)[b]
LM (mm^2/d)	28 ± (1.5)[b]	31 ± (1.4)[b]	53 ± (4.3)[a]	34 ± (2.9)[b]
BW (g/d)	818 ± (2)[a]	838 ± (2)[a]	681 ± (2)[b]	869 ± (2)[a]
85 kg				
BF (mm/d)	0.17 ± (0.01)[a]	0.13 ± (0.01)[b]	0.10 ± (0.03)[b]	0.11 ± (0.02)[b]
LM (mm^2/d)	26 ± (1.6)[b]	34 ± (1.5)[b]	51 ± (4.2)[a]	36 ± (2.8)[b]
BW (g/d)	829 ± (2)[a]	829 ± (2)[a]	691 ± (2)[b]	861 ± (2)[a]
90 kg				
BF (mm/d)	0.18 ± (0.02)[a]	0.13 ± (0.02)[b]	0.10 ± (0.03)[b]	0.11 ± (0.02)[b]
LM (mm^2/d)	24 ± (1.7)[c]	35 ± (1.6)[b]	49 ± (4.1)[a]	37 ± (2.6)[b]
BW (g/d)	850 ± (2)[a]	826 ± (2)[a]	713 ± (2)[b]	858 ± (2)[a]
95 kg				
BF (mm/d)	0.18 ± (0.02)[a]	0.14 ± (0.02)[a,b]	0.10 ± (0.03)[b]	0.12 ± (0.02)[b]
LM (mm^2/d)	22 ± (1.7)[c]	34 ± (1.7)[b]	48 ± (3.9)[a]	37 ± (2.3)[b]
BW (g/d)	883 ± (2)[a]	829 ± (2)[a]	746 ± (2)[b]	860 ± (2)[a]
100 kg				
BF (mm/d)	0.18 ± (0.02)[a]	0.15 ± (0.02)[a,b]	0.10 ± (0.03)[b]	0.14 ± (0.02)[a,b]
LM (mm^2/d)	21 ± (1.8)[c]	32 ± (1.9)[b]	47 ± (3.7)[a]	35 ± (2.1)[b]
BW (g/d)	928 ± (2)[a]	837 ± (2)[b]	790 ± (3)[b]	869 ± (2)[a,b]
105 kg				
B (mm/d)	0.18 ± (0.02)[a]	0.18 ± (0.02)[a]	0.10 ± (0.03)[b]	0.16 ± (0.02)[a,b]
LM (mm^2/d)	21 ± (2.1)[c]	29 ± (2.2)[b]	46 ± (3.7)[a]	32 ± (2.0)[b]
BW (g/d)	984 ± (3)[a]	852 ± (3)[b]	846 ± (3)[b]	883 ± (3)[b]
110 kg				
BF (mm/d)	0.17 ± (0.03)[a]	0.20 ± (0.03)[a]	0.10 ± (0.03)[b]	0.18 ± (0.02)[a]
LM (mm^2/d)	20 ± (3.0)[b]	25 ± (2.8)[b]	46 ± (3.9)[a]	27 ± (2.3)[b]
BW (g/d)	1051 ± (4)[a]	872 ± (4)[b]	912 ± (4)[b]	904 ± (4)[b]
115 kg				
BF (mm/d)	0.17 ± (0.04)[a]	0.23 ± (0.03)[a]	0.09 ± (0.04)[b]	0.21 ± (0.03)[a]
LM (mm^2/d)	20 ± (4.2)[b]	19 ± (3.8)[b]	46 ± (4.7)[a]	21 ± (3.1)[b]
BW (g/d)	1130 ± (6)[a]	899 ± (6)[b]	992 ± (6)[b]	929 ± (5)[b]

[a] BF = tenth-rib backfat; LM = loin muscle; BW = bodyweight.
[b] a,b LS means with different superscripts within a row differ ($P < 0.05$).

In winter, LM accretion rates were greater for hoop-reared pigs than confinement-reared pigs from 80 to 105 kg ($P < 0.05$) and at 110- and 115-kg BW ($P < 0.001$) (fig. 4). Greater LM accretion rates for hoop-reared pigs from 80 to 115 kg BW may suggest that they are still in the linear phase of their growth curve.

When studying BF and LM accretion curves for summer and winter, some generalizations can be made (figs. 1-4). In both seasons, hoop-reared pigs had more constant rates of accretion from 80 to 115 kg for BF and LM. Confinement pigs increased BF deposition and decreased LM accretion rates beginning at 100 kg. These differences between building types may be due to the lag in performance that hoop pigs experience because of environmental variation when placed in the hoop building. Thus, hoop-reared pigs from 80 to 115 kg may not have reached the inflection point of their growth curve, which may explain why the increase in BF accretion and decrease in LM accretion had not occurred by 115-kg BW.

Additionally, body weight gain (BW gain) is more constant in confinement buildings during both seasons, which may also be a reflection of fewer environmental stressors in the earlier stages of finishing (figs. 5 and 6). The more neutral environment may cause confinement-reared pigs to reach the point of inflection on their growth curve at a lighter weight. As a result, BF accretion rates in

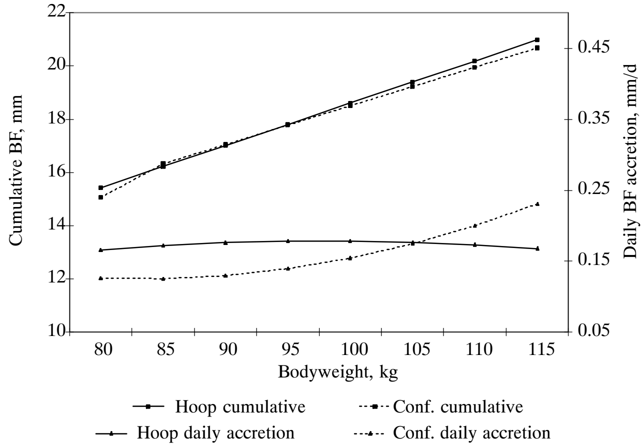

Figure 1. Cumulative and daily accretion curves for backfat of pigs reared in hoop and confinement buildings during summer.

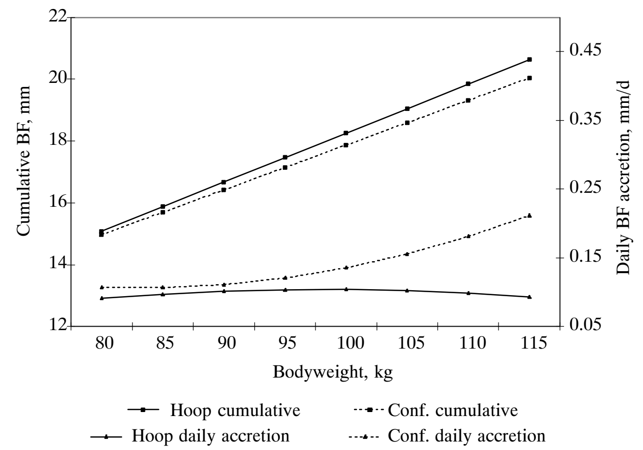

Figure 2. Cumulative and daily accretion curves for backfat of pigs reared in hoop and confinement buildings during winter.

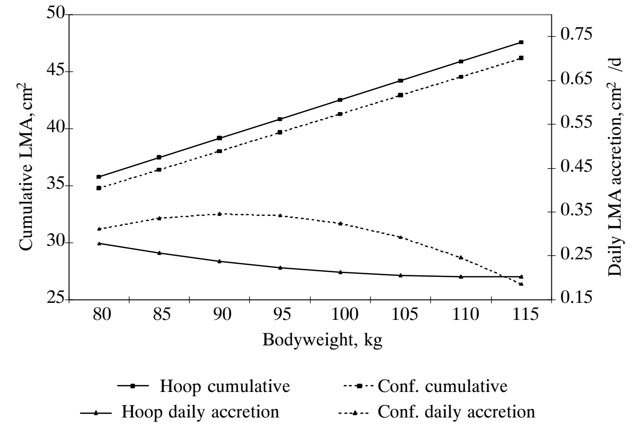

Figure 3. Cumulative and daily accretion curves for loin muscle area of pigs reared in hoop and confinement buildings in summer.

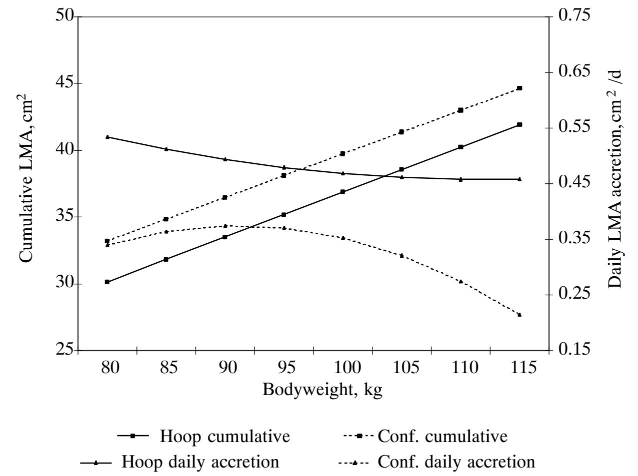

Figure 4. Cumulative and daily accretion curves for loin muscle area of pigs reared in hoop and confinement buildings in winter.

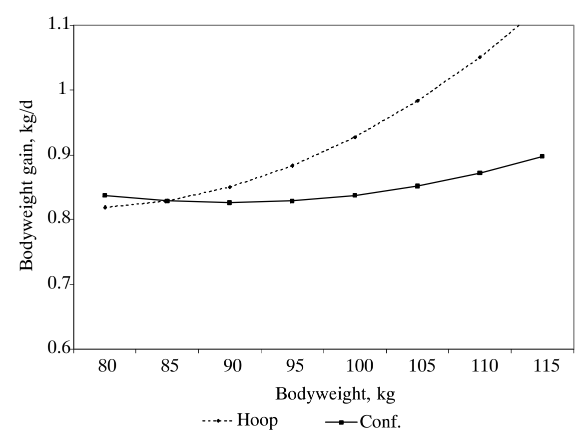

Figure 5. Comparison of daily bodyweight gain of pigs reared in hoop and confinement buildings during summer.

confinement were increasing while LM accretion rates were decreasing after 100 kg BW. Accordingly, the LM accretion rates for hoop-reared pigs from 80 to 115 kg are greater than in the other building/season subgroups. Pigs reared in an open-air structure in the winter should have the most difficulty adapting from the heated nursery to the cold hoop finishing building and a more severe lag in performance would likely occur (Larson et al., 2003). Hoop-reared pigs in winter may be in the linear phase of their growth curve as evidenced by the greater LM accretion rates and lower BF accretion rates in relation to the other building/season subgroups (figs. 1-4).

In summer, BW gain curves differed when comparing hoop- and confinement-reared pigs (fig. 5). Hoop- and confinement-reared pigs have similar BW gains from 80 to 90 kg and then there was a sharp increase in BW gain from 90 to 115 kg for the hoop-reared pigs. The BW gain of hoop-reared pigs was 91 g/d greater at 100 kg, 132 g/d greater at 105 kg, 179 g/d greater at 110 kg, and 231 g/d greater at 115 kg BW ($P < 0.05$).

In winter, BW gain curves for hoop- and confinement-reared pigs have the same shape as summer (figs. 5 and 6). However, the daily BW gain for hoop-reared pigs was 188 g/d less at 80-kg, 170 g/d less at 85-kg, and 145 g/d less at 90-kg BW than for confinement-reared pigs ($P < 0.001$) (fig. 6). At 95 kg, BW gain was 114 g/d less ($P < 0.05$). At 100- to 115-kg BW, BW gain was similar between both building types (fig. 9).

The difference in daily BW gain is probably due to environment. The hoop-reared pigs may have experienced some compensatory gain once they reached a weight where they could overcome the effects of temperature on their maintenance needs. As their maintenance needs were reduced in relation to their BW and average daily feed intake,

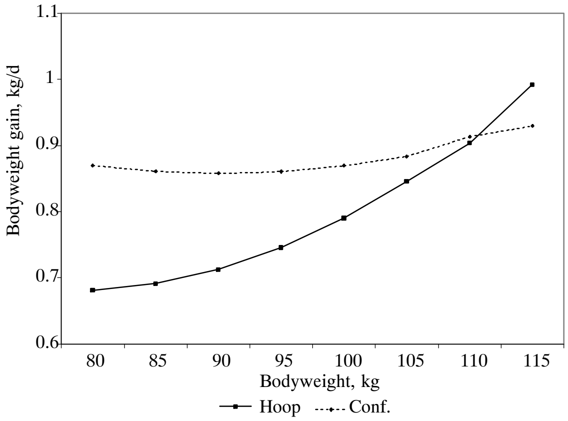

Figure 6. Comparison of bodyweight gain curves of pigs reared in hoop and confinement buildings in winter.

an increase in growth rate may occur due to the increase in available nutrients.

Conclusions

Although overall pig performance in hoop and confinement buildings is similar, some differences in accretion rates for bodyweight, backfat, and loin muscle area occurred from 80 to 115 kg during the finishing period. These differences are probably due to seasonal variation in the thermal environment. Performance of pigs reared in hoop buildings may be compromised early in the finishing period by their inability to overcome the difference between temperature and thermoneutrality. However, it appears that hoop-reared pigs compensated for earlier lags in performance by increased BW gain and LM accretion, along with less BF deposition compared with pigs in confinement at the same BW. This study provides some evidence to justify feeding pigs in hoops to heavier weights. Research studying accretion rates of pigs at a wider range of bodyweights will be needed to better understand the effects of environment and building type on pig performance.

Acknowledgements

This project was supported by the Hatch Act, State of Iowa funds, and the Leopold Center for Sustainable Agriculture. The authors acknowledge M. Hoge, J. Lampe, and D. Newcom for conducting the ultrasound scans; C. Jorgensen, T. Goode, and the ISU Rhodes Research Farm staff for animal care; A. Penner for data collection; and B. Thacker for veterinary consultation.

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