EFFECTS OF BIRTH WEIGHT AND PAYLEAN INCLUSION LEVEL ON THE GROWTH PERFORMANCE, CARCASS CHARACTERISTICS, AND FRESH PORK QUALITY PARAMETERS OF PIGS

BY

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THESIS

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ABSTRACT

The effects of birth weight and dietary Paylean inclusion level on the growth performance, carcass characteristics, and fresh pork quality parameters of pigs were evaluated using 72 barrows in a 2 part study. Part I was carried out from 3 wk post-weaning to 110 ± 2.0 kg BW as a RCBD with 1 treatment: Birth weight [Heavy, Medium, Light (average 1.5, 1.2, 0.9 kg, respectively)]. Pigs from the 3 birth weight classifications were selected from within the same birth litter. Part II was carried out from 110 ± 2.0 to 134 ± 3.2 kg BW as a RCBD using a 3 × 2 factorial arrangement of treatments: 1) Birth weight (Heavy, Medium, Light), and 2) dietary Paylean inclusion level (0 and 5 ppm). Pigs were housed in individual pens and were weighed at birth, weaning, and every two weeks thereafter in Part I and weekly during Part II. All feed additions and feed left in the feeder at the time of pig weighing were recorded and used in the calculation of average daily feed intake and gain:feed ratio. At 134 kg BW, pigs were shipped to the University of Illinois Meat Science Laboratory and harvested according to standard procedures. Standard carcass and meat quality measurements (subjective color, firmness, and marbling, Minolta color, and drip loss) were taken ~24 hr post-mortem, and Warner-Bratzler shear force was measured on cooked *Longissimus* muscle chops. The right side of each carcass was separated into skin, bone, and soft tissue, each tissue was weighed, and the soft tissue was ground. In Part I, light birth weight pigs had lower ($P < 0.05$) ADG (0.98 vs. 1.02 vs. 1.05, respectively; SEM 0.016 kg), but similar ($P > 0.05$) ADFI and G:F as medium and heavy birth weight pigs. In Part II, there were no treatment interactions for growth traits; the effects of birth weight on growth performance were similar to Part I. There was no effect ($P > 0.05$) of birth weight on HCW, carcass yield, or *Longissimus* muscle area, however, tenth rib backfat was greater (2.8 vs. 2.5 vs. 2.5 cm, respectively; SEM 0.13; $P < 0.05$), and predicted fat-free lean was lower (49.0 vs. 50.5 vs. 51.2%, respectively; SEM 0.57; $P < 0.01$) for light than medium and heavy birth weight pigs. In Part II, feeding Paylean at 5 ppm increased ADG (1.06 vs. 1.25 kg; SEM 0.033; $P < 0.001$), G:F (0.300 vs. 0.358; SEM 0.0065; $P < 0.001$) and carcass yield (76.5 vs. 77.0%; SEM 0.16; $P < 0.05$), but had no effect on tenth rib back fat thickness, *Longissimus* muscle area, or predicted fat-free lean. Results of this study confirm previous research on the effects of birth weight and Paylean on growth and carcass characteristics and suggest that the response to Paylean is similar across the birth weights evaluated.

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CHAPTER 1: LITERATURE REVIEW

A population of pigs is comprised of individual pigs, and consequently, individual growth rates. The effects of birth weight on the growth performance, carcass characteristics, and meat quality of pigs have been investigated in a number of studies. Light birth weight pigs have been shown to have slower growth rates compared to their heavier counterparts in several studies (Milligan et al., 2002; Quiniou et al., 2002; Wolter et al., 2002; Peterson et al., 2008). Compromised growth rates directly impact the profitability of production. Therefore, research has focused on the causes of variation in the growth performance due to piglet birth weight.

Determination of Birth Weight. Birth weight variation, by definition, must be determined during pregnancy prior to parturition. Therefore, research has focused on fetal nutrition via the nutrition of the sow to try to understand the causes of variation in birth weight. Pond (1973) reported that when sows were fed a protein restricted diet throughout gestation, piglet birth weight and subsequent weight gain was reduced by 20 to 30% compared to those fed a protein adequate diet. Similar results were reported by Atinmo et al. (1974) who found significantly lower mean piglet birth weight and subsequent growth rate during the growing-finishing period for progeny from sows fed diets with restricted protein levels. However, fetal nutrition may be affected by much more than the sow diet composition and quantity. For example, it has been shown that as the litter size increases, the mean piglet birth weight decreases (Johnson et al., 1999; Quiniou et al., 2002). Foxcroft (2006) attributed this phenomenon to increased ovulation rates and/or lower embryo and fetal mortality, leading to intrauterine crowding and growth retardation in the lightest fetuses. Light weight fetuses often do not have the placental surface area due to uterine crowding and, therefore, receive fewer nutrients. Consequently, light weight fetuses in utero may show the greatest benefit from increased sow nutrition during gestation by increasing mean piglet birth weight. This is evidenced by Dwyer et al. (1994), who reported that increased maternal feed intake from d 25 to d 80 of gestation resulted in improved growth rates in light birth weight pigs due to increased secondary muscle fiber number and higher feed efficiency from d 70 post-farrowing to 80 kg live weight. Several studies have found that increased sow nutrition during early gestation has either no effect, or even detrimental effects, on birth weight variation or on the growth performance of the progeny (Nissen et al., 2003; Bee, 2004; Cerisuelo et al., 2009). However, Cromwell et al. (1989) reported that feeding diets supplemented with fat to sows during the last 23 d of gestation led to higher mean piglet birth weight and higher pre-weaning growth rate than for non-supplemented diets, findings similar to Seerley (1974) and Seerley et al. (1978). Although these nutritional strategies may prove somewhat effective, light birth weight pigs and the resulting variation in growth rate still exist within a population of pigs.

Other strategies to alleviate fetal under nutrition have also been investigated. Some studies have evaluated injecting sows with growth hormone in an attempt to stimulate nutrient uptake. Rehfeldt et al. (2001) reported that providing exogenous porcine somatotropin to sows to stimulate fetal nutrient uptake in early gestation had a greater response in increasing mean piglet birth weight in light weight fetuses compared to their heavier counterparts, since larger fetuses were already receiving adequate fetal nutrition. Furthermore, Rehfeldt and Kuhn (2006) showed that providing growth hormone to sows in early- and mid-gestation led to an increase in growth rate for all light and medium weight fetuses compared to heavy weight fetuses. However, the use of exogenous hormone therapy to increase birth weight is not widely practiced.

Effect of Birth Weight on Growth Performance. Several studies have evaluated the effects of birth weight on pre-weaning growth performance. Wolter et al. (2002) reported that heavy weight piglets at birth were heavier at weaning compared to light weight piglets at birth. Similar results for growth performance have been reported in a number of studies (Milligan et al., 2002; Quiniou et al., 2002; Peterson et al., 2008). One hypothesis as to why light weight pigs exhibit lower performance was proposed by Campbell and Dunkin (1982), who suggested that light birth weight pigs may under perform compared to heavy weight pigs due to a lower capacity for milk intake during the suckling period. Light weight pigs are significantly smaller, by definition, compared to heavier pigs and consequently would be less able to compete for teats with higher milk output and are likely to consume less milk. Campbell and Dunkin (1982) reported that birth weight did not affect growth rate of piglets to 21 d of age, but that heavy birth weight piglets consumed more milk per suckle on an absolute basis than light birth weight piglets, and that the milk intake per unit of body weight was similar between the two groups. Wolter et al. (2002) also showed that heavy birth weight pigs at birth consume more liquid milk replacer compared to light birth weight pigs, suggesting that light weight pigs may have a lower overall capacity for milk intake.

Most studies evaluating the effect of birth weight on post-weaning growth performance have found that light weight pigs at birth grow slower than their heavier counterparts, however, results relating to the effect of birth weight on feed intake and gain:feed ratio vary. Powell and Aberle (1980) reported light birth weight pigs grew slower than heavy birth weight pigs and had lower gain:feed ratio. However, Wolter et al. (2002) reported that heavy birth weight pigs (mean of 1.8 kg live weight) had faster growth rates, higher feed intake, but similar gain:feed ratio, and required seven less days to reach 110 kg live weight compared to light birth weight pigs (mean of 1.3 kg live weight). Gondret et al. (2005) performed a similar experiment in which two birth weight classifications were used [i.e. light (0.8 – 1.1 kg birth weight) versus heavy (1.8 – 2.1 kg birth weight] and reported an 8% reduction in growth rate from weaning to 102 kg live weight and an additional 12 d requirement to reach 102 kg live weight for light birth weight pigs. These authors also reported that light birth weight pigs had similar feed intake, but lower gain:feed ratio than heavy birth weight pigs. Rehfeldt and Kuhn (2006) performed an experiment evaluating three birth weight categories [light, medium and heavy (mean of 0.9, 1.4, and 1.8 kg birth weight, respectively)] and showed that light birth weight pigs had the lowest growth rates. In a similar study, Peterson et al. (2008) reported that light weight pigs (mean of 1.2 kg birth weight) at birth had lower average daily gain, similar feed intake, and numerically lower gain:feed ratio compared to medium and heavy weight pigs (mean of 1.5 and 1.9 kg birth weight, respectively) at birth, findings that were similar to those of Bérard et al. (2008). Collectively, these studies suggest that light birth weight pigs have lower growth rate and feed efficiency compared to their heavier counterparts.

***Effect of Birth Weight on Carcass Characteristics and Meat Quality Parameters*.** Several studies have investigated the effects of birth weight on carcass characteristics. Peterson et al. (2008) reported that heavy birth weight pigs tended to have higher hot and cold carcass weights, but similar carcass yield, as medium and light birth weight pigs. In contrast, Bee (2004) reported no effect of birth weight on hot carcass weight, findings similar to Gondret et al. (2006) and Bérard et al. (2008). Also, Hegarty and Allen (1978) reported similar cold carcass weight between heavy and light birth weight pigs. However, Bérard et al. (2008) reported higher carcass yield for light birth weight pigs than medium and heavy birth weight pigs. In addition, Hegarty and Allen (1978) and Peterson et al. (2008) reported no effect of birth weight on *Longissimus* muscle area, however, Rehfeldt et al. (2008) found that *Longissimus* muscle area was lower in light birth weight pigs compared to medium and heavy birth weight pigs. Gondret et al. (2006) reported that light birth weight pigs had higher tenth rib back fat thickness compared to heavy birth weight pigs. These findings are in contrast to Hegarty and Allen (1978) and Peterson et al. (2008) who reported no effect of birth weight on tenth rib back fat thickness. Generally speaking, however, the effects of birth weight on carcass characteristics have been small.

The effects of birth weight on meat quality parameters have been evaluated in a number of studies. Several studies have reported higher intramuscular fat content in light birth weight pigs compared to their heavier birth weight counterparts (Hegarty and Allen, 1978; Rehfeldt et al., 2008). A number of studies have shown no effect of birth weight on either pH 45 (Gondret et al., 2005; Bérard et al., 2008; Peterson et al., 2008) or ultimate pH (Nissen et al., 2004; Gondret et al., 2005; Bérard et al., 2008; Rehfeldt et al., 2008). However, Rehfeldt et al. (2008) reported higher drip loss for light compared to medium and heavy birth weight pigs. Generally speaking, however, reported differences in meat quality traits between birth weights have been small.

Effect of Birth Weight on Muscle Fiber Type, Number, and Area. Another hypothesis as to why light birth weight pigs have lower growth performance than heavier birth weight pigs is that they have fewer muscle fibers. Increases in muscle fiber number occur in utero, and the number is fixed at birth (Wigmore and Stickland, 1983). Several studies have evaluated the association between birth weight and muscle fiber number and area. Hegarty and Allen (1978) reported that light weight pigs at birth had higher muscle fiber diameter, but fewer muscle fibers in total in comparison to average weight pigs at birth. Similarly, Bee (2004) showed that overall fiber area was larger in light than in heavy birth weight pigs. In addition, piglets weighing under 0.85 kg at birth have been shown to have a lower ratio of secondary to primary myofibers (Aberle, 1984) than piglets weighing over 1 kg at birth. Secondary muscle fibers develop in utero and surround the primary fibers, and much of the post-natal growth of the animal results from hypertrophy of these secondary fibers. Wigmore and Stickland (1983) showed that secondary muscle fiber number was lower in light birth weight pigs, and attributed part of this variation to fetal under-nutrition. It has also been reported, however, that primary fiber number is the primary cause of variation in fiber number between litters, and also accounts for a significant portion of the birth weight variation within a litter (Dwyer and Stickland, 1991). As stated previously, many researchers have attempted to decrease the variation in birth weight through increasing maternal nutrition. By providing increased nutrition to the sow during critical stages of development, such as the time the secondary muscle fibers are forming, progeny growth performance and lean accretion may be improved. Dwyer et al. (1994) showed that increasing maternal dietary energy intake from d 25 to d 50 of gestation resulted in an increase in the number of secondary fibers in light birth weight pigs, and that subsequent growth rate and feed efficiency was increased. In contrast, Nissen et al. (2003) reported no improvement in muscle fiber number or area in progeny from sows fed higher energy diets from d 25 to d 50 or d 25 to d 70 of gestation, and consequently no increase in growth rate of different birth weights. There are mixed results, however, when evaluating the association between increased sow nutrition and muscle fiber number, and the impact on progeny growth rate.

PAYLEAN

Paylean (ractopamine hydrochloride) is a beta agonist that can be fed to late-finishing pigs to increase growth rate, feed efficiency, and lean growth by repartitioning nutrients toward protein synthesis instead of lipogenesis (Apple et al., 2007).

***Effect of Paylean on Growth Performance*.** The effect of Paylean on pig growth performance has been documented in a number of studies. A recent meta-analysis of studies evaluating the growth response to Paylean (Apple et al., 2007) concluded that feeding Paylean at 5 ppm to pigs in late finishing resulted in a significant increase in average daily gain and gain:feed ratio (mean improvement of 12.0% and 10.0%, respectively). In addition, Apple et al. (2007) reported that feeding 10 or 20 ppm of Paylean compared to 0 ppm increased growth rate by 11.8% and feed efficiency by 13.3% for 10 ppm and 16.7% for 20 ppm. Feeding up to 10 ppm of Paylean did not affect average daily feed intake, however, a reduction in feed intake was observed when pigs were fed diets containing 20 ppm of Paylean (Apple et al., 2007).

***Effect of Paylean on Carcass Characteristics and Meat Quality Parameters*.** A number of studies have concluded that feeding Paylean during late-finishing increases carcass weight by an average of 2.3% (Stites et al., 1991; Armstrong et al., 2004; See et al., 2005) and dressing percent an average of 0.2 percentage units (Watkins et al., 1990; Stites et al., 1991; Armstrong et al., 2004; Carr et al., 2005; See et al., 2005). Apple et al. (2007) reported that hot carcass weight, *Longissimus* muscle area, and fat-free lean percentage increased as the dietary level of Paylean increased from 0 to 5 ppm by an average of 2.3%, 6.5%, and 0.9 percentage units, respectively. However, the effect of Paylean on tenth rib back fat thickness has not been consistent among studies. Some studies suggest a reduction in backfat thickness with Paylean (Aalhus et al., 1990; Watkins et al., 1990; Herr et al., 2001) while others show no effect (Armstrong et al., 2004; Brumm et al, 2005; See et al., 2005). Furthermore, Paylean has been shown to have no detrimental effect on *Longissimus* muscle quality measurements such as ultimate pH (Aalhus et al., 1990; Herr et al., 2001; Carr et al., 2005), subjective color scores (Crome et al., 1996; Herr et al., 2001), or subjective marbling scores (Apple et al., 2007). In general, Paylean increases average daily gain and gain:feed ratio in late-finishing swine, and has no detrimental effects on fresh pork quality.

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CHAPTER 2: EFFECTS OF BIRTH WEIGHT AND DIETARY PAYLEAN INCLUSION LEVEL ON THE GROWTH PERFORMANCE, CARCASS CHARACTERISTICS, AND FRESH PORK QUALITY PARAMETERS OF PIGS.

INTRODUCTION

Pork processors continue to demand a more uniform product, which the swine producer in turn must provide. In order to meet these demands, producers are trying to identify and minimize the variability within pigs that are sent for harvest, while still maximizing throughput and profitability. Sources of variation in growth performance can be numerous, but include factors such as genetics, litter size, birth and weaning weight, nutrition, the use of growth modifiers in late-finishing, pig environment and so on. Piglet birth weight has been investigated to identify its contribution to variation in growth rate and fresh pork quality. Milligan et al. (2002) reported that litters with high variation in birth weight had higher mortality rates compared to litters with lower variation in birth weight, and that piglets with low birth weight had higher mortality rates compared to heavy weight pigs at birth. Furthermore, several studies have reported that low birth weight pigs grow slower compared to heavy birth weight pigs (Powell and Aberle, 1980; Wolter et al., 2002; Rehfeldt and Kuhn, 2006). Although it is generally accepted that light weight pigs at birth have slower growth rates than their heavier counterparts, the extent and cause(s) of this difference has not been clearly established.

In addition, Paylean is a beta agonist that can be fed to late-finishing pigs to increase growth rate, feed efficiency, and lean growth by repartitioning nutrients toward protein synthesis instead of lipogenesis. As stated previously, light birth weight pigs have been shown to have slower growth rates compared to their heavier birth weight counterparts, possibly due to lower lean accretion rates. This reduction in lean accretion may alter the response to growth modifiers such as Paylean in late-finishing.

Therefore, the objective of this study was to determine the effect of birth weight and of dietary Paylean inclusion level on the growth performance, carcass characteristics, and fresh pork quality of pigs and to discover the interaction, if any, between birth weight and Paylean.

MATERIALS AND METHODS

The protocol for this research was approved by the University of Illinois Institutional Animal Care and Use Committee prior to the start of the study (IACUC #09050).

***Experimental Design and Treatments*.** This study was divided into two parts: Part I (growth performance study) was from 3-weeks post-weaning to 110 kg live weight, and Part II: (Paylean feeding period) was from 110 kg to 134 kg live weight. Part I was conducted as a randomized complete block design with one treatment and three levels: Birth weight classification (Light, Medium, and Heavy). Part II was conducted as a randomized complete block design with a 3 x 2 factorial arrangement of the following treatments: 1) Birth weight classification (Light, Medium, and Heavy) and 2) Dietary Paylean inclusion level (0 and 5 ppm). There were 24 replicates blocked by room in Part I of the study, and 12 replicates blocked by room in Part II of the study. Individual pig was considered the experimental unit in both parts of the study. Birth weight classifications were as follows:

Light (average of 0.9 kg ± 0.26; range of 0.7 – 1.8 kg)

Medium (average of 1.2 kg ± 0.27; range of 0.7 – 2.0 kg)

Heavy (average of 1.5 kg ± 0.27; range of 1.1 – 2.3 kg)

Animals and Allotment. Within 24 h of birth, all piglets (barrows and gilts) were weighed and given a unique identification (ear tag) and barrows were assigned to one of the three birth weight classifications within a litter. Three or six barrows (1 or 2 from each birth weight classification) were identified within each litter. Selected barrows were randomly cross-fostered from within birth weight classification to form litters of a common birth weight classification (i.e. Light, Medium, or Heavy) with an equal number of piglets in each litter. Non-test piglets (remaining barrows and gilts) were cross-fostered onto litters of the same birth weight classification, e.g., heavy non-test piglets were placed in litters of heavy piglets and so on. All piglets were weighed again 24 h prior to weaning (20 $\pm$ 1.9 d of age). Previously selected barrows were chosen for the growth performance study on the basis of birth litter of origin and birth weight classification. Therefore, 3 or 6 littermates were chosen from each birth litter of origin (1 or 2 from each birth weight classification) so that at least 3 pigs (1 from each birth weight classification) within a common birth litter were allotted to the growth performance study.

Pre-test Management. During farrowing and lactation, sows and piglets were managed according to standard commercial procedures. On approximately d 109 of gestation, sows were moved into farrowing crates that were 1.1 m x 3.1 m (width x length); the farrowing pen was 2.4 m x 3.7 m (width x length). Farrowing pens had plastic coated slotted flooring; the crates were equipped with a feed trough for the sow, and nipple drinkers for both the sow and piglets. The ambient air temperature in the farrowing room was maintained at 22° C throughout lactation using thermostatically controlled fan ventilation and space heaters. During the first week after farrowing, piglets were provided with supplemental heat via a heat lamp suspended approximately 45 cm above the floor on one side of the farrowing crate. At d 4 post-farrowing, piglet processing was carried out and consisted of docking of tails, castration of entire males, and injection of all piglets with 1 ml iron dextran and 0.5 ml of Excede (for the prevention of scours). Prior to farrowing, sows were fed approximately 2.5 kg/d of a corn and soybean meal based lactation diet that was formulated to meet or exceed NRC (1998) nutrient requirements. After farrowing, sows were fed approximately 2.5 kg/d until d 3, at which time they were offered ad libitum access to the lactation diet

At weaning, 78 piglets (26 piglets from each birth weight classification) were transported to the University of Illinois using a standard livestock trailer. Pigs were allowed a 3-week acclimation period during which they were housed in groups of 6 or 7 in a mechanically ventilated wean-to-finish facility. The facility consisted of four identical rooms with fully slotted concrete flooring and pen divisions and gates consisting of vertical steel rods. Each room was 7.32 m long and 8.23 m wide with 2.1 m high ceilings. There were 8 pens per room each measuring 1.83 m x 3.66 m providing a minimum floor space allowance of 0.96 m^2 per pig. Temperature was controlled using thermostatically controlled exhaust fans and a heater in each room. The room temperature was set at 30.5° C for the first week and then gradually lowered until it reached 25° C where it was held for the duration of the acclimation period. Supplemental heat was provided to each pen for the first two weeks post-weaning via a heat lamp suspended 75 cm above two rubber mats, each measuring 60 cm x 60 cm (length x width). Temperature and humidity levels were recorded using HOBO H8 loggers that were programmed to record readings every 12 minutes.

Pigs were offered ad libitum access to feed via a two-hole dry box feeder, and water was freely available via a cup drinker. A standard 2-phase dietary program using corn and soybean meal based diets formulated to meet or exceed NRC (1998) recommendations for nutrient requirements was used. For the first 7 days post-weaning, pigs were provided an additional ~500 g of dry feed on the two rubber mats in each pen twice per day. Diet phases were changed on the basis of pig body weight (Table 1).

Growth Performance Study Management. At the conclusion of the 3-week acclimation period, pigs were moved to an individual housing facility located approximately 40 meters from the acclimation facility where they were housed for the duration of the growth performance study. The facility consisted of two identical rooms with fully slotted plastic flooring and pen divisions and gates consisted of vertical steel rods. Each room was 18.0 m long and 4.6 m wide with 2.1 m high ceilings and a central 0.6 m wide aisle. There were 36 pens in each room measuring 1.0 m x 2.0 m, providing a floor space allowance of 2.0 m^2 per pig. Temperature was regulated by thermostatically controlled fans and a heater suspended in each room. The room temperature was set at 25° C for the first week and then gradually lowered until it reached 19° C where it was held for the duration of the study period. Temperature and humidity levels were recorded using HOBO H8 loggers that were programmed to record readings every 12 minutes.

During Part I of the study (3 weeks post-weaning to 110 kg live weight), a 5-phase dietary program was used with diets being based on corn and soybean meal and formulated to meet or exceed NRC (1998) recommendations for nutrient requirements. Pigs were offered ad libitum access to feed via a single space stainless steel dry box feeder mounted to the front gate of each pen and water was freely available via a cup drinker mounted on the pen partition 30 cm from the back of the pen. Diet phases were changed on the basis of pig body weight (Table 1).

Paylean Feeding Period Management. Part II of the study period (Paylean feeding period) was carried out between 110 kg and 134 kg live weight. Pigs were housed in the same facility and managed similarly to Part I. A single phase corn and soybean meal based diet containing either 0 or 5 ppm Paylean inclusion was used throughout this period. This diet was formulated to meet or exceed NRC (1998) recommendations for nutrient requirements for finishing pigs with the exception that protein and lysine levels were set to meet the requirement of pigs fed Paylean at 5 ppm (Table 2). Pigs were offered ad libitum access to feed and water was freely available via a cup drinker throughout the Paylean feeding period.

***Growth Measurements*.** Part I of the study was carried out from the end of week 3 post-weaning to 110 kg live weight. During Part I, pigs were individually weighed every two weeks until they reached 110 kg live weight. All feed additions and feed remaining in the feeder at the time of pig weighing were measured to determine feed intake and gain:feed ratio. Beginning at ~30 kg live weight, all pigs were ultrasonically scanned at the time of pig weighing using an Aloka Model 500V B-mode ultrasound scanner fitted with an Aloka 5011 probe (Corometrics Medical Systems, Wallingford, CT). A transverse image was taken over the tenth rib and back fat thickness (over the middle of the longissimus muscle) and longissimus muscle area were measured on the image.

Part II (Paylean feeding period) of the study was carried out from 110 kg live weight to 134 kg live weight. During Part II, pigs were individually weighed once per week until they reached 134 kg live weight. All feed additions and feed remaining in the feeder at the time of pig weighing were measured to determine feed intake and gain:feed ratio. All pigs were ultrasonically scanned at the time of pig weighing using an Aloka Model 500V B-mode ultrasound scanner fitted with an Aloka 5011 probe (Corometrics Medical Systems, Wallingford, CT). A transverse image was taken over the tenth rib and back fat thickness (over the middle of the longissimus muscle) and longissimus muscle area were measured on the image. At 134 kg live weight, pigs were removed from test and transported to the University of Illinois Meat Sciences Laboratory (MSL) for harvest.

***Carcass Characteristics*.** Pigs were held in lairage overnight at the MSL with access to water but not feed. They were harvested the following morning according to standard procedures. Immediately after harvest, the offal, leaf fat, front feet, tail, and head were collected and weighed, and the heart, lungs, kidneys, and spleen were separated and weighed. The stomach was separated from the small intestine immediately posterior to the pyloric sphincter and from the esophagus immediately anterior to the esophageal sphincter. The stomach was emptied, rinsed, allowed to dry, and weighed. The entire small intestine was separated from the large intestine immediately anterior to the ileo-cecal valve. The large intestine, including the cecum, was separated from the rectum and anus ~10 cm anterior to the anus. The small intestine and large intestine were separated from the mesentery, and all digesta was removed using a water hose and a copper tubing attachment that could be inserted into the tract. All of the water was removed from the tract and the empty weights were recorded for the small and large intestines.

Approximately one hour after harvest, carcasses were weighed to determine hot carcass weight and placed into a chiller and held overnight at 4° C. Approximately 24 h post-harvest, carcasses were weighed to determine cold carcass weight and standard carcass grading measurements were taken on the left side of each carcass, including midline back fat thickness at the first and last rib, and the last lumbar vertebra. Carcass length was measured from the cranial tip of the aitch bone to the last lumbar vertebra. The carcasses were ribbed at the tenth rib and the tenth rib back fat was measured using a stainless steel ruler; the longissimus muscle was traced on acetate paper and longissimus muscle area was measured from the tracing using an area line meter (Super PLANIX α Polar Planimeter; Tokyo, Japan). Percent lean of the carcass was calculated using the NPPC (2000) equation for ribbed carcasses: ((21.896*10^{th} rib back fat depth, in) + (3.005*10^{th} rib longissimus muscle area, in^2) + (0.465 * hot carcass weight, lbs)) / hot carcass weight, lbs * 100.

Meat quality parameters were measured at the same time as standard carcass grading measurements. Ultimate pH was measured at the tenth rib using a MPI pH Meter (Model C033, Meat Probes, Inc., USA). Subjective color (6 point scale; 1 = pale to 6 = dark red; NPPC, 2000), marbling (continuous scale; 1 = 1% intra-muscular lipid to 10 = 10% intra-muscular lipid; NPPC, 2000), and firmness (5 point scale; 1 = soft to 5 = very firm; NPPC, 1991) scores were assessed on the cut surface of the longissimus muscle at the tenth rib. Objective color measurements (Minolta L*, a*, and b*) were taken on the cut surface of the longissimus muscle at the tenth rib using a CR-300 Minolta Chromameter (Minolta Camera, Osaka, Japan) with settings of illuminant D65 and 0° viewing angle. A section of boneless loin from the longissimus muscle immediately anterior to the tenth rib was removed from the left side of each carcass and one 1.0 cm chop and two 2.5 cm chops were cut and trimmed of epimysium and external fat. The 1.0 cm chop was weighed, placed in a Whirl-pak bag and suspended for 24 h in a 4° C cooler, and reweighed to determine drip loss. One 2.5 cm chop was used for proximate analysis and the other 2.5 cm chop was used for Warner-Bratzler shear force determination. Chops used for Warner-Bratzler shear force were aged for 14 d in a 4° C cooler and then frozen (-20° C). Subsequently, chops were thawed overnight at 4° C, trimmed to a uniform size and cooked on a Farberware Open Hearth grill (Model 455 N, Walter Kidde, Bronx, NY). Internal temperature was monitored using copper-constantan thermocouples (Type T, Omega Engineering, Stanford, CT) connected to a digital scanning thermometer (Model 92000-00, Barnart Co., Barington, IL). Chops were weighed, cooked on one side to an internal temperature of 35° C, turned over and cooked to a final internal temperature of 70° C, and reweighed to calculate percent cooking loss. Chops were allowed to cool and four cores (1.3 cm) were removed parallel to the orientation of the muscle fibers. Cores were sheared using a Texture

Analyzer TA.HD Plus (Texture Technologies Corp., Scarsdale, NY; Stable Microsystems, Godalming, UK) with a blade speed of 200 mm/min and a load cell capacity of 980.4 N (100 kg). Shear force was determined for each core, and these values were averaged for each sample.

Carcass composition was measured by separating the right side of each carcass into skin, bone, and soft tissue components. Each component was weighed, and the soft tissue was ground through a Hobart Model 4152 Grinder (Hobart Corporation, Troy, OH) and 12 representative sub-samples were taken from the ground mixture and these were homogenized in a Talsa Model C40P Bowl Chopper (Stancase Equipment Company, Jersey City, NJ). Two 500 g samples were taken and frozen and stored for 7 days at which point they were thawed at room temperature and proximate analysis of the carcass was performed according to the procedures of Novakofski et al. (1989).

Statistical Analysis. All data were tested for normality using the PROC UNIVARIATE procedure of SAS (SAS Inst. Inc., Cary, NC). Morbidity and mortality data, which were not normally distributed were analyzed using a Chi-square rank-based test (Steel and Torrie, 1980) using the PROC RANKS procedure of SAS. Data meeting the criteria for normality were analyzed using the PROC MIXED procedure of SAS. Least-squares means were compared using the PDIFF and STDERR options of SAS. Data from Part I were analyzed as a randomized complete block design with 1 treatment (birth weight classification). The model included the fixed effects of birth weight classification and random effects of room and replicate nested within room. Data from Part II were analyzed as a randomized complete block design with 2 treatments (birth weight classification and Paylean inclusion level). The model included the fixed effects of birth weight classification and Paylean inclusion level, and the two-way interaction, and random effects of room and replicate nested within room. Individual pig was the experimental unit in both parts of the growth study and for the carcass evaluation.

RESULTS AND DISCUSSION

Part I. Growth performance data for Part I (3-weeks post-weaning to 110 kg live weight) of the study are presented in Table 3. By study design, there was a difference ($P < 0.001$) between birth weight categories (Light, Medium, and Heavy) for birth weight and this weight difference was maintained between birth weight categories at each interim weighing. Overall average daily gain from 3-weeks post-weaning to 110 kg live weight was lower ($P < 0.05$) for light birth weight pigs compared to medium and heavy birth weight pigs (6.1 and 7.1%, respectively). These findings are similar to results from Powell and Aberle (1980), Wolter et al. (2002), and Rehfeldt and Kuhn (2006). In addition, Gondret et al. (2005) reported an 8% reduction in overall growth rate from weaning to 102 kg live weight for light (0.8 - 1.05 kg live weight) compared to heavy (1.75 - 2.05 kg live weight) birth weight pigs. Peterson et al. (2008) reported that light (mean of 1.2 kg live weight) birth weight pigs had lower average daily gain when compared to medium (mean of 1.5 kg live weight) and heavy (mean of 1.9 kg live weight) birth weight pigs (5.3 and 6.1%, respectively), results that are very similar to the results of the current study. Because of these differences in growth rate, light birth weight pigs in the current study required more days ($P < 0.05$) to reach 110 kg live weight than medium and heavy birth weight pigs (5 and 8 d, respectively), which is in agreement with Wolter et al. (2002), Gondret et al. (2005), Rehfeldt and Kuhn (2006), and Peterson et al. (2008). Average daily feed intake for the overall study period did not differ ($P > 0.05$) between birth weight categories (Table 1), which is in agreement with previous research by Gondret et al. (2005) and Peterson et al. (2008). In contrast, Wolter et al. (2002) reported that light (1.3 kg live weight) birth weight pigs had lower daily feed intake from weaning to 110 kg live weight when compared to heavy (1.8 kg live weight) birth weight pigs. Some studies (Powell and Aberle, 1980; Bérard et al., 2008) have shown reductions in feed efficiency for light birth weight pigs. However, in the present study, there was no effect ($P > 0.05$) of birth weight on gain:feed ratio from 3-weeks post-weaning to 110 kg live weight. This is in agreement with Peterson et al. (2008) who reported no difference ($P > 0.05$) between light, medium, and heavy birth weight pigs for feed efficiency, however, in that study, light birth weight pigs had numerically lower gain:feed ratio compared to medium and heavy birth weight pigs. Furthermore, Wolter et al. (2002) reported similar feed efficiency between light and heavy birth weight pigs. Differences between studies in the effect of birth weight on feed intake and feed efficiency may reflect, in part at least, differences in the weight ranges over which the comparisons were carried out. However, collectively, these results suggest that light birth weight pigs have lower growth rates from 3-weeks post-weaning to 110 kg live weight, but similar feed efficiency, as medium and heavy birth weight pigs.

Part II. Growth performance data for Part II of the study (110 kg live weight to 134 kg live weight) are presented in Table 4. There were no interactions ($P > 0.05$) between birth weight category and Paylean inclusion level for live weight, average daily gain, average daily feed intake, or gain:feed ratio, suggesting that the response to Paylean was similar across the birth weight categories. The effect of birth weight on growth performance was generally similar to that observed in Part I of the study. Light birth weight pigs were lighter ($P < 0.05$) at the final weighing compared to medium and heavy birth weight pigs. In addition, light birth weight pigs tended ($P = 0.07$) to have lower growth rate from 110 to 134 kg live weight and consequently required more days to reach 134 kg live weight compared to medium and heavy birth weight pigs. There was no effect ($P > 0.05$) of birth weight on average daily feed intake; however, feed efficiency from 110 to 134 kg live weight was lower for light birth weight pigs compared to medium and heavy birth weight pigs.

Pigs fed Paylean at 5 ppm had greater average daily gain from 110 to 134 kg live weight (17.9%), and consequently, reached market weight (134 kg live weight) 2.7 d sooner than pigs fed the control treatment (0 ppm). Similarly, Apple et al. (2007) reported on a meta-analysis that feeding Paylean at 5 ppm increased growth rate by 12.0% compared to 0 ppm. In the present study, feeding Paylean did not affect ($P > 0.05$) feed intake. This result agrees with most research, which shows no impact of feeding Paylean at 5 ppm on feed intake (Watkins et al., 1990; Stites et al., 1991; Armstrong et al., 2004; See et al., 2005). In the present study, feeding Paylean at 5 ppm increased gain:feed ratio (by 19.3%) compared to untreated pigs, which is in agreement with Stites et al. (1991) and Uttaro et al. (1993) who reported a 17% improvement in feed efficiency for pigs fed 5 ppm Paylean compared to pigs fed 0 ppm Paylean. In addition, Apple et al. (2007) reported that feeding Paylean at 5 ppm compared to 0 ppm increased feed efficiency by 10%.

***Carcass and Meat Quality Measurements*.** Least-squares means for the effects of birth weight and Paylean inclusion level on carcass characteristics, meat quality parameters, and carcass composition are presented in Tables 5, 6, and 7, respectively.

There was an interaction between birth weight category and Paylean inclusion level for last rib back fat thickness ($P = 0.04$) and last lumbar vertebra back fat thickness ($P = 0.03$), however, differences between the interaction means were small and of little biological or practical significance. There was no effect ($P > 0.05$) of birth weight category on hot carcass weight, chilled carcass weight, carcass yield, *Longissimus* muscle area, or carcass length. However, light birth weight pigs had greater ($P < 0.05$) tenth rib back fat thickness compared to medium and heavy birth weight pigs, resulting in a lower predicted fat-free lean percentage for light birth weight pigs. Similarly, Gondret et al. (2006) reported that light birth weight pigs had lower percentage lean in the carcass and had greater back fat depth at the tenth rib than heavy birth weight pigs. In addition, Rehfeldt and Kuhn (2006) reported that light birth weight pigs had lower lean tissue and higher body fat content compared to medium and heavy birth weight pigs. A number of studies have reported no differences in carcass composition between light and heavy birth weight pigs (Powell and Aberle, 1980; Wolter et al., 2002; Nissen et al., 2004), however, Wolter et al. (2002) was the only study that harvested pigs at a similar weight as used in the present study.

Feeding Paylean at 5 ppm compared to 0 ppm increased hot carcass weight and carcass yield, which is in agreement with the findings of Apple et al. (2007), but had no effect on chilled carcass weight or *Longissimus* muscle area. Pigs fed Paylean at 5 ppm had lower carcass length compared to pigs fed the control Paylean treatment. Furthermore, pigs fed Paylean at 5 ppm inclusion had numerically greater back fat thickness at the tenth rib compared to pigs fed 0 ppm Paylean inclusion. Uttaro et al. (1993) reported that feeding 5 ppm compared to 0 ppm Paylean to pigs lowered tenth rib back fat depth. In contrast, several studies have reported little or no effect of feeding diets with 5 ppm Paylean inclusion on tenth rib back fat depth (Watkins et al., 1990; Stites et al., 1991; Herr et al., 2001; Armstrong et al., 2004; See et al., 2005). In addition, Apple et al. (2007) reported little impact of diets with 5 ppm Paylean inclusion on predicted lean content, which is similar to the results of the present study.

Least-squares means for the effects of birth weight and Paylean inclusion level on meat quality characteristics are presented in Table 6. There was an interaction between birth weight category and Paylean inclusion level for Minolta a* and b* measurements. Feeding Paylean at 5 ppm compared to 0 ppm had no effect on a* or b* values for medium or heavy birth weight pigs, however, feeding diets at 5 ppm Paylean lowered a* and b* values for light birth weight pigs. Light birth weight pigs had similar fat percentage of the *Longissimus* muscle, but higher subjective marbling scores than medium and heavy birth weight pigs, which is in agreement with Powell and Aberle (1980) and Rehfeldt et al. (2008), and higher subjective firmness scores than medium birth weight pigs, with heavy birth weight pigs being intermediate in this respect. Values for pH 45 tended (P = 0.05) to be higher for light than medium and heavy birth weight pigs, which is in contrast with Rehfeldt et al. (2008) who reported that light birth weight pigs had lower pH 45 values; however, ultimate pH was not affected by birth weight. *Longissimus* muscle drip loss was lower for light birth weight pigs than medium birth weight pigs, with heavy birth weight pigs being intermediate in this respect, which is in agreement with Rehfeldt et al. (2008). Furthermore, Nissen et al. (2004) reported no effect of birth weight category on ultimate pH, drip loss, or Minolta color values. In addition, heavy birth weight pigs had higher shear force values than light and medium birth weight pigs. *Longissimus* muscle moisture percentage carcass moisture and fat percentage were not different between birth weight categories. Furthermore, there was no effect of birth weight category on carcass body components.

Values for pH 45 were higher (P < 0.05) for pigs fed 5 ppm Paylean than 0 ppm Paylean inclusion. *Longissimus* muscle moisture and carcass moisture and fat percentage were not affected by Paylean level. However, *Longissimus* muscle fat percentage was higher for pigs fed 5 ppm Paylean than 0 ppm, but subjective marbling scores were not affected by Paylean inclusion level. A number of studies have evaluated feeding 5 ppm Paylean inclusion on meat quality characteristics of pigs and reported no effect of Paylean on ultimate pH values, *Longissimus* muscle color or firmness, or *Longissimus* muscle drip loss percentage (Stites et al., 1994; Herr et al., 2001; Rincker et al., 2005). Generally speaking, the effects of Paylean inclusion level on meat quality traits were small.

CONCLUSIONS

The results of this study suggest that light birth weight pigs have substantially lower growth rate (~6%), but similar feed efficiency from 3 wk post-weaning to 110 kg BW compared to medium and heavy birth weight pigs. The effects of birth weight in Part II of this study were generally similar to Part I. Feeding Paylean at 5 ppm increased live weight, growth rate, and feed efficiency of pigs from 110 to 134 kg BW. The lack of an interaction in the Paylean feeding period suggests that the response to Paylean is similar across the birth weights evaluated. The lower predicted lean content in light birth weight pigs is of interest due to the practical implications such differences have within the swine industry. These findings suggest that further research evaluating birth weight is warranted, predominantly, to understand impacts on body composition with increasing live weight, and that new approaches to manage sub-population of pigs on the basis of birth weight could have substantial merit in the commercial swine industry.

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TABLES

Table 1. Dietary phases, composition, and calculated analysis (as-fed basis) from 6 to 110 kg BW.

	Dietary phase						
Item	Nursery 1	Nursery 2	Nursery 3	Grower 1	Grower 2	Finisher 1	Finisher 2
BW range, kg	6-8	8-11	11-23	23-45	34-68	68-90	90-110
Ingredient, %							
Corn	43.39	51.38	61.02	62.51	70.50	74.62	78.60
Dehulled soybean meal	22.28	27.52	32.43	31.86	23.91	19.92	15.95
Spray-dried plasma	2.50	0.00	0.00	0.00	0.00	0.00	0.00
Select Menhaden fish meal	5.00	3.75	0.00	0.00	0.00	0.00	0.00
Spray dried whey	10.00	5.00	0.00	0.00	0.00	0.00	0.00
Lactose	10.00	5.00	0.00	0.00	0.00	0.00	0.00
Choice white grease	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Mono-calcium Phosphate, 21% P	0.25	0.75	1.15	0.85	0.85	0.80	0.80
Limestone	0.75	0.75	0.95	0.85	0.85	0.80	0.80
Salt	0.30	0.30	0.50	0.50	0.50	0.50	0.50
Zinc oxide	0.30	0.30	0.00	0.00	0.00	0.00	0.00
Vitamin premix	0.05	0.05	0.05	0.03	0.03	0.03	0.03
Trace mineral premix	0.10	0.10	0.10	0.10	0.09	0.09	0.08
Lysine HCl	0.23	0.28	0.38	0.20	0.20	0.20	0.20
DL-Methionine	0.15	0.18	0.15	0.05	0.03	0.00	0.00
L-Threonine	0.11	0.15	0.15	0.05	0.05	0.05	0.05
Carbadox	0.25	0.25	0.13	0.00	0.00	0.00	0.00
Spray-dried blood cells	1.25	1.25	0.00	0.00	0.00	0.00	0.00
Calculated analysis							
Crude protein, %	22.40	22.00	20.80	20.39	17.35	15.83	14.32
Total ileal digestible lysine, %	1.45	1.40	1.30	1.15	0.95	0.85	0.75
Ca, %	0.81	0.79	0.70	0.61	0.58	0.54	0.53
P, %	0.66	0.68	0.64	0.57	0.54	0.51	0.50
ME, kcal/kg	3,453	3,441	3,452	3,467	3,470	3,475	3,477

Table 2. Dietary phases, composition, and calculated analysis (as-fed basis) from 110 to 134 kg BW.

	Dietary phase	
Item	No Paylean	Paylean
Ingredient, %		
Corn	70.75	70.73
Dehulled soybean meal	23.89	23.89
Choice white grease	3.00	3.00
Mono-calcium Phosphate, 21% P	0.75	0.75
Limestone	0.75	0.75
Salt	0.50	0.50
Vitamin premix	0.03	0.03
Trace mineral premix	0.08	0.08
Lysine HCl	0.20	0.02
L-Threonine	0.06	0.06
Paylean	0.00	0.03
Calculated analysis		
Crude protein, %	17.40	17.40
Total ileal digestible lysine, %	0.95	0.95
Ca, %	0.53	0.53
P, %	0.52	0.52
ME, kcal/kg	3,476	3,476

Table 3. Least square means for the effect of birth weight on the growth performance of pigs to 110 kg live weight (Part 1).

	Birth weight classification				
Item	Light	Medium	Heavy	SEM	*P*-value
Number of pigs	24	24	24	-	-
Body weight, kg					
Birth	0.9[c]	1.2[b]	1.5[a]	0.05	0.001
Week 3 post-weaning	11.8[b]	14.0[a]	14.7[a]	1.25	0.001
Week 5 post-weaning	20.9[b]	24.4[a]	25.5[a]	1.86	0.001
Week 6 post-weaning	25.6[c]	29.4[b]	31.3[a]	2.28	0.001
Week 8 post-weaning	39.1[c]	44.0[b]	46.4[a]	2.49	0.001
Week 10 post-weaning	52.9[c]	58.2[b]	61.4[a]	2.58	0.001
Week 12 post-weaning[1]	67.7[c]	73.8[b]	77.2[a]	2.92	0.001
End (~110 kg live weight)[2]	110.2	110.9	111.5	0.397	0.10
Days on test	100.5[b]	95.5[a]	92.2[a]	2.73	0.001
Average daily gain, kg					
Week 3 - 5 post-weaning	0.60[b]	0.69[a]	0.72[a]	0.045	0.001
Week 5 - 6 post-weaning	0.70[b]	0.74[b]	0.83[a]	0.051	0.001
Week 6 - 8 post-weaning	0.97[b]	1.05[a]	1.08[a]	0.025	0.004
Week 8 - 10 post-weaning	0.50	0.48	0.48	0.016	0.18
Week 10 - 12 post-weaning	1.06	1.12	1.13	0.032	0.16
Week 12 - End[3]	1.17	1.22	1.23	0.027	0.19
Week 3 - End	0.98[b]	1.02[a]	1.05[a]	0.016	0.001
Average daily feed intake, kg					
Week 3 - 5 post-weaning	0.81[b]	0.92[a]	1.00[a]	0.183	0.001
Week 5 - 6 post-weaning	1.19	1.29	1.31	0.063	0.14
Week 6 - 8 post-weaning	1.57[b]	1.72[a]	1.79[a]	0.070	0.001
Week 8 - 10 post-weaning	1.97[b]	2.15[a]	2.22[a]	0.072	0.001
Week 10 - 12 post-weaning	2.35[b]	2.52[a]	2.62[a]	0.092	0.003
Week 12 - End[3]	2.99	2.96	3.04	0.055	0.52
Week 3 - End	2.22	2.26	2.29	0.062	0.19
Gain:feed, kg:kg					
Week 3 - 5 post-weaning	0.752	0.760	0.723	0.0841	0.35
Week 5 - 6 post-weaning	0.597	0.566	0.627	0.0294	0.24
Week 6 - 8 post-weaning	0.620	0.613	0.605	0.0173	0.62
Week 8 - 10 post-weaning	0.504	0.477	0.483	0.0164	0.18
Week 10 - 12 post-weaning	0.452	0.449	0.432	0.0110	0.34
Week 12 - End[3]	0.393	0.406	0.404	0.0074	0.33
Week 3 - End	0.445	0.452	0.455	0.0057	0.26

[a,b,c]Means within a row with differing superscripts are significantly different ($P < 0.05$)

[1]Some pigs began the Paylean feeding period at week 12 post-weaning.

[2]All pigs ended the birth weight growth performance period at ~110 kg live weight.

[3]Calculations are from week 12 post-weaning to 110 kg live weight.

Table 4. Least square means for the effect of birth weight and dietary Paylean inclusion level on the growth performance of from 110 kg to 134 kg BW (Part II).

	Birth weight classification				Paylean level			*P*-values		
Item	Light	Medium	Heavy	SEM	0 ppm	5 ppm	SEM	Birth weight	Paylean	Birth weight x Paylean
Number of pigs	23	24	24	-	35	36	-	-	-	-
Body weight, kg										
Start (~110 kg live weight)	110.2	110.9	111.5	0.40	110.9	110.9	0.33	0.11	0.96	0.80
Week 1	116.2	117.4	118.6	0.79	116.7	118.1	0.64	0.10	0.14	0.39
Week 2	123.3[b]	125.2[a]	125.6[a]	0.66	123.1[b]	126.3[a]	0.55	0.04	0.001	0.74
End (~134 kg live weight)[1]	133.7	134.8	134.5	0.64	133.4[b]	135.3[a]	0.53	0.46	0.01	0.13
Days on test	22.4[b]	20.0[a]	19.7[a]	0.70	22.0[b]	19.3[a]	0.63	0.003	0.001	0.67
Average daily gain, kg										
Start - Week 1	1.15	1.16	1.24	0.087	1.06[b]	1.31[a]	0.072	0.74	0.02	0.87
Week 1 - 2	1.02	1.12	1.05	0.072	0.95[b]	1.17[a]	0.060	0.54	0.01	0.49
Week 2 - End	1.21	1.29	1.42	0.095	1.18[b]	1.43[a]	0.080	0.23	0.02	0.46
Start - End	1.08	1.19	1.19	0.039	1.06	1.25	0.033	0.07	0.001	0.88
Average daily feed intake, kg										
Start - Week 1	3.18	3.13	3.10	0.107	3.19	3.08	0.090	0.85	0.31	0.58
Week 1 - 2	3.17	3.09	2.95	0.084	3.06	3.02	0.068	0.18	0.63	0.69
Week 2 - End	3.42	3.42	3.49	0.097	3.41	3.48	0.081	0.82	0.52	0.23
Start - End	3.51	3.53	3.48	0.062	3.52	3.50	0.055	0.80	0.68	0.79
Gain:feed, kg:kg										
Start - Week 1	0.354	0.368	0.410	0.0228	0.337[b]	0.417[a]	0.0186	0.19	0.004	0.46
Week 1 - 2	0.324	0.374	0.371	0.0315	0.325[b]	0.388[a]	0.0295	0.15	0.01	0.98
Week 2 - End	0.348	0.377	0.397	0.0198	0.343[b]	0.404[a]	0.0171	0.15	0.004	0.69
Start - End	0.309[b]	0.337[a]	0.341[a]	0.0080	0.300[b]	0.358[a]	0.0065	0.02	0.001	0.89

[a,b]Means within a row with differing superscripts are significantly different ($P < 0.05$).

[1]Pigs were sent for harvest at a fixed target weight of 134 $\pm$ 3 kg live weight.

Table 5. Least square means for the effect of birth weight and Paylean inclusion level on carcass characteristics of pigs.[1]

Item	Birth weight classification				Paylean level			*P*-values		
	Light	Medium	Heavy	SEM	0 ppm	5 ppm	SEM	Birth weight	Paylean	Birth weight x Paylean
Number of pigs	23	24	24	-	35	36	-	-	-	-
Carcass characteristics										
Harvest live weight, kg	128.9	130.0	129.5	0.58	128.3[b]	130.6[a]	0.49	0.37	0.001	0.13
Hot carcass weight, kg	99.4	99.2	99.4	0.24	99.0[b]	99.7[a]	0.20	0.85	0.04	0.20
Chilled carcass weight, kg	97.0	96.6	97.0	0.26	96.5	97.2	0.23	0.57	0.06	0.27
Carcass yield, %	76.8	76.6	76.8	0.18	76.5[b]	77.0[a]	0.16	0.86	0.04	0.20
Predicted lean content, %[2]	49.0[b]	50.5[a]	51.2[a]	0.57	50.2	50.2	0.53	0.004	0.95	0.37
Loin eye area, cm^2	46.26	46.32	47.68	1.400	46.00	47.55	2.581	0.45	0.16	0.46
Backfat thickness, in										
First rib	2.00	1.86	1.89	0.057	1.94	1.89	0.050	0.15	0.44	0.38
Tenth rib	1.12[a]	1.00[b]	0.97[b]	0.050	1.02	1.05	0.044	0.05	0.51	0.25
Last rib	1.03	0.99	0.99	0.049	0.99	1.01	0.044	0.67	0.72	0.04
Birth weight classification										
Light	-	-	-	-	1.04[ab]	1.03[ab]	0.059	-	-	-
Medium	-	-	-	-	0.91[b]	1.06[a]	-	-	-	-
Heavy	-	-	-	-	1.04[ab]	0.95[ab]	-	-	-	-
Last lumbar vertebra	0.87	0.85	0.82	0.032	0.82	0.88	0.027	0.52	0.11	0.03
Birth weight classification										
Light	-	-	-	-	0.84[abc]	0.91[ab]	0.041	-	-	-
Medium	-	-	-	-	0.78[c]	0.92[a]	-	-	-	-
Heavy	-	-	-	-	0.85[abc]	0.80[bc]	-	-	-	-
Carcass length, cm	34.92	34.97	34.90	0.201	35.21[a]	34.65[b]	0.185	0.92	0.001	0.34

[a,b,c]Means within a row with differing superscripts are significantly different ($P < 0.05$)

[1]Data corrected to a common harvest live weight of 129.5 kg.

[2]Fat-free lean calculated using NPPC (2000) equation.

Table 6. Least square means for the effect of birth weight and Paylean inclusion level on meat quality parameters of pigs.[1]

Item	Birth weight classification				Paylean level			*P*-values		
	Light	Medium	Heavy	SEM	0 ppm	5 ppm	SEM	Birth weight	Paylean	Birth weight x Paylean
Number of pigs	23	24	24	-	35	36	-	-	-	-
Longissimus muscle meat quality										
Subjective color	2.56	2.36	2.37	0.166	2.43	2.42	0.145	0.58	0.96	0.97
Subjective marbling	2.18[a]	1.68[b]	1.53[b]	0.249	1.71	1.88	0.228	0.05	0.40	0.07
Subjective firmness	2.80[a]	2.33[b]	2.52[ab]	0.195	2.42	2.68	0.180	0.05	0.08	0.32
pH 45	6.19	5.98	6.02	0.068	5.98[b]	6.14[a]	0.058	0.05	0.03	0.08
Ultimate pH	5.50	5.46	5.46	0.022	5.46	5.48	0.019	0.27	0.31	0.14
Minolta values										
L*	51.24	53.69	54.15	1.011	53.46	52.61	0.894	0.06	0.38	0.06
a*	8.81	8.90	8.69	0.479	9.06	8.54	0.426	0.90	0.23	0.03
Light	-	-	-	-	9.84[a]	7.79[b]	0.593	-	-	-
Medium	-	-	-	-	8.74[ab]	9.07[ab]	-	-	-	-
Heavy	-	-	-	-	8.61[ab]	8.77[ab]	-	-	-	-
b*	5.24	5.99	5.86	0.431	5.94	5.46	0.376	0.35	0.26	0.02
Light	-	-	-	-	6.26[a]	4.23[b]	0.549	-	-	-
Medium	-	-	-	-	5.99[a]	5.99[a]	-	-	-	-
Heavy	-	-	-	-	5.55[ab]	6.16[a]	-	-	-	-
Drip loss, %	3.49[b]	5.54[a]	5.14[ab]	0.628	5.09	4.35	0.535	0.05	0.26	0.26
Cook loss, %	23.78	23.02	24.97	1.184	24.06	23.79	1.072	0.23	0.78	0.09
Shear force, kg	2.97[b]	3.06[b]	3.56[a]	0.216	3.13	3.27	0.205	0.002	0.30	0.16
Proximate analysis, %										
Moisture	73.96	74.07	74.00	0.243	74.19	73.83	0.219	0.90	0.09	0.96
Fat	2.69	2.23	2.24	0.331	2.17[b]	2.60[a]	0.316	0.14	0.03	0.73
Carcass proximate analysis, %										
Moisture	57.24	58.32	58.21	0.596	57.77	58.08	0.508	0.35	0.63	0.29
Fat	26.55	25.13	25.30	0.769	25.88	25.44	0.656	0.34	0.58	0.33

[a,b,c]Means within a row with differing superscripts are significantly different ($P < 0.05$)

[1]Data corrected to a common harvest live weight of 129.5 kg.

Table 7. Least square means for the effect of birth weight and Paylean inclusion level on the body composition of pigs.[1]

	Birth weight classification				Paylean level			*P*-values		
Item	Light	Medium	Heavy	SEM	0 ppm	5 ppm	SEM	Birth weight	Paylean	Birth weight x Paylean
Number of pigs	23	24	24	-	35	36	-	-	-	-
Head, kg	6.48	6.40	6.47	0.089	6.47	6.43	0.076	0.70	0.68	0.03
Birth weight classification										
Light	-	-	-	-	6.52[ab]	6.44[ab]	0.117			
Medium					6.54[ab]	6.26[b]				
Heavy					6.34[ab]	6.59[a]				
Front feet, kg	0.89	0.89	0.91	0.027	0.90	0.89	0.02	0.70	0.72	0.87
Tail, kg	0.06	0.07	0.06	0.009	0.07	0.06	0.01	0.49	0.33	0.74
Leaf fat, kg	1.84	1.77	1.71	0.134	1.85	1.70	0.126	0.57	0.12	0.13
Offal, kg	13.60	13.84	13.47	0.348	13.8	13.5	0.318	0.48	0.21	0.84
Heart, kg	0.47	0.45	0.45	0.012	0.46	0.45	0.01	0.21	0.43	0.28
Lungs, kg	0.57	0.59	0.62	0.019	0.62[a]	0.56[b]	0.016	0.27	0.00	0.88
Kidneys, kg	0.39	0.39	0.37	0.012	0.39	0.37	0.01	0.53	0.06	0.89
Liver, kg	1.93	1.87	1.84	0.043	1.94[a]	1.82[b]	0.037	0.28	0.01	0.32
Spleen, kg	0.21	0.20	0.21	0.011	0.21	0.20	0.01	0.49	0.30	0.52
Stomach, kg	0.60	0.58	0.59	0.012	0.59	0.58	0.01	0.64	0.65	0.40
Small intestine, kg	1.42	1.33	1.35	0.056	1.36	1.38	0.048	0.41	0.72	0.16
Large intestine, kg	1.57	1.61	1.68	0.064	1.65	1.59	0.056	0.44	0.31	0.66
Anus and bladder, kg	0.51	0.51	0.55	0.023	0.52	0.52	0.02	0.28	0.74	0.15
Mesentery, kg	2.93	2.83	2.78	0.078	2.86	2.83	0.069	0.28	0.71	0.31
Penis, kg	0.30	0.31	0.31	0.015	0.30	0.31	0.01	0.92	0.69	0.67
Side weight, kg	47.85	47.91	48.04	0.237	47.86	48.01	0.207	0.79	0.52	0.10
Skin, kg	3.42	3.38	3.40	0.047	3.45[a]	3.35[b]	0.04	0.83	0.04	0.31
Bone, kg	4.79	4.89	4.94	0.081	4.99[a]	4.77[b]	0.07	0.36	0.01	0.19
Soft tissue, kg	39.45	39.43	39.49	0.245	39.17[b]	39.74[a]	0.21	0.97	0.02	0.22

[a,b]Means within a row with differing superscripts are significantly different ($P < 0.05$)

[1]Data corrected to a common harvest live weight of 129.5 kg.