The impact of dietary supplementation of arginine during gestation in a commercial swine herd: I. Gilt reproductive performance

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ABSTRACT: Supplemental arginine (**Arg**) during gestation purportedly benefits fetal development. However, the benefits of a gestational Arg dietary strategy in commercial production are unclear. Therefore, the objectives of this study examined Arg supplementation during different gestational stages and the effects on gilt reproductive performance. Pubertal gilts (n = 548) were allocated into 4 treatment groups: Control (n = 143; 0% supplemental Arg) or 1 of 3 supplemental Arg (1% as fed) treatments: from 15 to 45 d of gestation (n = 138; Early-Arg); from 15 d of gestation until farrowing (n = 139; Full-Arg); or from 85 d of gestation until farrowing (n = 128; Late-Arg). At farrowing, the number of total born (**TB**), born alive (**BA**), stillborn piglets (**SB**), mummified fetuses (**MM**), and individual piglet birth weights (**BiWt**) were recorded. The wean-to-estrus interval (**WEI**) and subsequent sow reproductive performance (to third parity) were also monitored. No significant effect of supplemental Arg during any part of P0 gestation was observed for TB, BA, SB, or MM ($P \geq 0.29$). Offspring BiWt and variation among individual piglet birth weights did not differ (P = 0.42 and 0.89, respectively) among treatment groups. Following weaning, the WEI was similar among treatments (average of 8.0 ± 0.8 d; P = 0.88). Litter performance over 3 parities revealed a decrease (P = 0.02) in BA for Early-Arg fed gilts compared with all other treatments, whereas TB and WEI were similar among treatments over 3 parities ($P >$ 0.05). There was an increased proportion of sows with average size litters (12 to 16 TB) from the Full-Arg treatment sows (76.8% ± 3.7%) when compared with Control (58.7% ± 4.2%; P = 0.01); however, the proportion of sows with high (>16 TB) and low (<12 TB) litters was not different among treatments (P = 0.20). These results suggest that gestational Arg supplementation had a minimal impact on reproductive performance in first parity sows. These data underscore the complexity of AA supplementation and the need for continued research into understanding how and when utilizing a gestational dietary Arg strategy can optimize fetal development and sow performance.

Key words: arginine, litter, pig, production, sow, swine

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INTRODUCTION

Individual AA supplementation has been extensively studied in growing pigs; however, similar attention has not been given to specific AA requirements in sows, despite the fact that they have been continually selected for improved reproductive performance. Arginine (**Arg**) requirements have attracted attention due to its apparent positive influence on fetal development (Bérard and Bee, 2010) and litter size (Wu et al., 2013). Furthermore, Arg supplementation has been shown to benefit sows

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by reducing body condition loss during lactation (Laspiur et al., 2006).

As a precursor for ornithine, nitric oxide, and creatine synthesis, Arg is a critical metabolic precursor for vascularization and rapid cellular growth during conceptus development and attachment (Fozard et al., 1980; Wyss and Kaddurah-Daouk, 2000; Wu et al., 2013). Due to the increased fetal and placental requirement of compounds synthesized from Arg, it is possible that Arg could be a limiting AA during gestation. However, the effect of supplemental Arg and timing of dietary changes on reproductive performance is poorly understood in sows (Moehn et al., 2011). Therefore, the objectives of this study were to examine whether Arg supplementation during different gestational stages affects gilt reproductive performance. Specifically, this project tested the hypothesis that supplementing 1% dietary Arg in gilts in a commercial production setting during specific stages of gilt (parity 0, **P0**) gestation would improve reproductive capacity as assessed by litter characteristics and subsequent reproductive performance.

MATERIALS AND METHODS

Animals and Experimental Design

All procedures involving animals were approved by the Iowa State University Institutional Animal Care and Use Committee. Commercially reared, pubertal gilts (PIC 1050, Hendersonville, TN) were selected for breeding and included in the trial based on physical display of estrus during a 3-wk period. Gilts selected for breeding were approximately 240 d of age, with at least one prior estrus, and serviced twice via artificial insemination with pooled semen (DNA 600, Columbus, NE) before placement in gestation pens (15 head per pen). In total, 660 gilts were serviced and were assigned to the trial, with 165 gilts per dietary treatment over a 20-d breeding period.

Diet Formulation and Gestation Management

All diets were supplied via an auger and feed drop system common in commercial swine facilities (Chore-Time, Milford, IN). Diets were mixed at a commercial mill, with 1% supplemental L-Arg (free-base; Ajinomoto Animal Nutrition North America, Inc., Chicago, IL) mixed into the diet with a red tracer for subsequent verification of protocol adherence. The Control diet formulation served as the base diet for all treatments, supplying 0.65% (approximately 15.9 g/d) Arg; treatment diet was formulated by adding 1% L-Arg, to the base control diet, supplying a total of 1.28% Arg (approximately 25 g/d). Both the Control and high arginine diets met or exceeded the requirements for gilts (NRC, 2012). Diet composition for both Control and Arg treatments are shown in Table 1. Diets were provided to the gilts as a mash. Each batch of feed delivered was sampled (0.5-kg sample) and analyzed for total AA content to verify appropriate nutrient levels (Table 2). All gilts were supplied with an average of 2.6 kg/d until day 30 of gestation to reduce aggression stress prior to pregnancy establishment, and 2.3 kg/d from day 30 to farrowing.

Gilts were assigned randomly to dietary treatment based on estrus expression and selection for breeding. Due to the placement of gilts in gestation pens and group feeding, treatments were pre-assigned to gestation pens on a rotating basis. Each group of gilts serviced during the trial phase was included under a dietary treatment as follows: Control (n = 143; 0% supplemental L-Arg), or 1

Table 1. Composition of gestation diets (as-fed)[1]

Ingredient, %	Control	Arginine
Corn	58.14	57.55
Dried distillers grains with solubles, 8% oil	37.73	37.35
Live yeast, single-cell protein[2]	0.08	0.07
Biotin, 200 mg	0.03	0.03
Calcium	2.28	2.26
L-Lys (50%)	0.65	0.64
Salt	0.32	0.31
Antimicrobial[3]	0.33	0.32
Vitamin and mineral premix[4]	0.15	0.15
Choline chloride, 60%	0.15	0.15
Zinc sulfate	0.08	0.07
Phytase	0.05	0.05
L-Trp	0.02	0.02
L-Thr	0.01	0.01
L-Arg	—	1
Red tracer	—	0.03

[1]From day 15 of gestation to farrow (approximately 116 d of gestation), gestation dietary treatments were provided at 2.3 kg/d, based on timing treatment assignment.

[2]*Saccharomyces cerevisiae* live yeast (Actisaf Sc47 HR+, Phileo, France).

[3]Liquid antimicrobial blend of aqueous formaldehyde (37 % solution) and propionic acid for pathogen control in complete feeds (Sal CURB, Kemin, Des Moines).

[4]Vitamin premix, supplied per kilogram of diet: 11,045 IU of vitamin A, 1,766 IU of vitamin D3, 83 IU of vitamin E, 2.2 mg of menadione, 44.2 mg of niacin, 7.1 mg of riboflavin, 22.1 mg of pantothenic acid, 0.03 mg of vitamin B12, 1.65 mg of folic acid, 0.23 mg of d-biotin, 1.1 mg of thiamin, 4.4 mg of pyridoxine, 120 mg of zinc, 97.5 mg of iron, 50.3 mg of manganese, 15.0 mg of copper, 0.50 mg of iodine, 0.30 mg of selenium, 0.20 mg of chromium, 110 mg of Celcan 9x (Nutriquest, Mason City, IA).

of 3 Arg treatments (1% supplemental L-Arg) provided from days 15 to 45 of gestation (**Early-Arg**; n = 138); from day 15 of gestation until farrowing (**Full-Arg**; n = 139); or from day 85 of gestation until farrowing (**Late-Arg**; n = 128). Dietary treatments were initiated on day 15 of gestation because feeding excess levels of energy or protein prior to day 10 of gestation may negatively affect embryo survival prior to implantation (Bazer et al., 1968; Ashworth, 1991; Rehfeldt et al., 2012). All gilts that were removed from test pens due to illness, injury, or reproductive failure were recorded and omitted from farrowing data analysis. Removed gilts were not replaced, and whole pen feed allocation was evaluated and adjusted if necessary, a minimum of once per week, based on pen inventory.

Between days 85 and 110 of gestation, gilts were delivered to the sow farm and placed in individual gestation stalls for transitional holding until approximately 5 d prior to farrowing; gilts remained on respective gestational dietary treatments during this time. Each farrowing room was filled based on breed date and contained no less than 5 gilts from each gestation diet treatment. Dietary treatment administration continued as a once-daily hand feeding of approximately 2.3 kg per gilt until the day of farrowing. Once farrowed, each gilt was allowed ad libitum access to a common lactation diet, the composition of which is presented in Table 3.

Table 2. Assayed and determined dietary component analysis[1]

Component	Control	Arginine
Assayed components, %		
DM	87.46	87.63
CP	14.88	16.30
Arg	0.65	1.28
Cys	0.37	0.37
His	0.54	0.53
Leu	0.26	0.26
Lys	1.02	1.00
Met	0.70	0.69
Phe	0.53	0.53
Thr	1.60	1.58
Trp	0.75	0.78
Val	0.12	0.12
SID AA content[2], %		
Arg	0.54	1.19
Cys	0.21	0.23
His	0.29	0.29
Leu	1.34	1.38
Lys	0.61	0.62
Met	0.22	0.23
Phe	0.57	0.59
Thr	0.39	0.39
Trp	0.09	0.10
Val	0.52	0.53

[1]Complete feed samples were analyzed by Ajinomoto Heartland, Inc., Chicago, IL.

[2]Standard ileal digestibility AA content, determined utilizing assayed total AA (%) adjusted by NRC (2012) SID values of diet ingredients.

Data Collection

Within 24 h of farrowing, gilt performance was evaluated by litter characteristics, including number of total pigs born (**TB**), pigs born alive (**BA**), stillborn piglets (**SB**), and mummified fetuses (**MM**), and offspring gender. Offspring classified for immediate euthanasia because of low viability, deformity, or injury were recorded as BA and included as such in litter characteristic analysis. All fully formed offspring (BA and SB) were weighed individually at birth (**BiWt**). Preweaning mortality was evaluated within 24 h of birth and for the duration of the lactation phase.

Finally, litters were classified by number of TB pigs to evaluate the possible interactions between litter size and gestational Arg treatment. Litters were classified based on the normal distribution of

Table 3. Composition of lactation diet[1], as-fed basis[1]

Ingredient, %	Lactation
Corn	45.05
Dried distillers grains with solubles, 8% oil	30.00
Soybean meal	17.00
Corn oil	4.42
Calcium	2.03
L-Lysine HCl 78.8%	0.48
Antimicrobial[2]	0.33
Salt	0.30
Vitamin and mineral premix[3]	0.15
Choline, liquid 70%	0.09
L-Thr	0.08
Phytase	0.05
Live yeast, single-cell protein[4]	0.03
L-Trp	0.02

[1]Supplied ad libitum to all sows at farrowing.

[2]Liquid antimicrobial blend of aqueous formaldehyde (37% solution) and propionic acid for pathogen control in complete feeds (Sal CURB, Kemin).

[3]Vitamin and mineral premix, supplied per kilogram of diet: 11,045 IU of vitamin A, 1,766 IU of vitamin D3, 83 IU of vitamin E, 2.2 mg of menadione, 44.2 mg of niacin, 7.1 mg of riboflavin, 22.1 mg of pantothenic acid, 0.03 mg of vitamin B12, 1.65 mg of folic acid, 0.23 mg of d-biotin, 1.1 mg of thiamin, 4.4 mg of pyridoxine, 120 mg of zinc, 97.5 mg of iron, 50.3 mg of manganese, 15.0 mg of copper, 0.50 mg of iodine, 0.30 mg of selenium, 0.20 mg of chromium, 110 mg of Celcan 9x (Nutriquest, Mason City, IA).

[4]*Saccharomyces cerevisiae* live yeast (Actisaf Sc47 HR+, Phileo, France).

litter sizes was observed, with 68% of litters falling within the average, 12 to 16 TB pigs per litter. High TB (18%) were classified as litters > 16 TB, and low TB (13%) included litters with <12 TB.

Wean-to-Estrus Interval and Longevity Evaluation

Wean-to-estrus interval (**WEI**) was recorded as the number of days post-weaning until the first behavioral estrus. Wean-to-estrus interval, farrowing interval, lifetime TB, and number weaned through subsequent parities, P0 to P3, were extracted from production system databases (Metafarms, Burnsville, MN). Each sow completing the P0 maternal dietary treatments were then included in retention analysis through P3 production.

Statistical Analysis

Statistical analyses were performed utilizing a mixed linear regression model (PROC MIXED, SAS 9.0, Cary, NC). Individual sow and litter data were evaluated with treatment as the main fixed effect, and breed week acting as a block, and gestation pen classified as a random effect. Breed week was utilized as a block to account for differences that may occur due to the extended breeding period. A mixed effect logistical regression (SAS, PROC GLIMMIX) was performed to conduct proportion analysis of litter sex structure, sow retention rate, and litters within TB classifications across maternal dietary treatments. Sex analysis included a random effect of sow nested in gestation pen, whereas retention rate analysis only included a fixed effect of maternal dietary treatment. Sows participating in cross-foster events were removed from preweaning mortality and WEI analyses. In cases of irreconcilable data errors, production anomaly or statistical outlier, litters were removed from the analysis (n = 27). Standard error was estimated with a Satterthwaite adjustment for estimating degrees of freedom under a random effect. All values reported are of least square mean, and maximum estimated SEM was reported in tables for each main effect comparison. The Tukey–Kramer method was used to adjust for multiple comparisons among classification groups.

RESULTS

No Significant Effect of Arg Supplementation on Litter Size Was Observed

No significant effect of supplementing Arg during specific phases of gestation was observed ($P \geq 0.29$) on the number of TB (14.3 ± 0.2), BA (13.1 ± 0.2), SB (0.9 ± 0.1), or MM (0.4 ± 0.1) farrowed during P1. Average BiWt of BA (P = 0.20) and fully formed pigs (BA + SB; P = 0.33) was not significantly different across treatments. Variation of BiWt within litter was also not different ($P \geq 0.73$) among treatments. Number of males and females per litter nor BiWt by sex was not affected ($P \geq 0.41$) by treatment (Table 4).

An increased (P = 0.01) percentage of sows with average TB litters (Fig. 1A) was observed for sows in the Full-Arg (76.8%) treatment group when compared with the Control (58.7%), although no significant effect of maternal dietary Arg supplementation on the percentage of sows producing high TB (Fig. 1B) or low TB (Fig. 1C) litters was observed (P = 0.20). The effect of maternal diet and TB classification interaction on BiWt was also evaluated. Interestingly, a tendency for increased BiWt (P = 0.08) in low TB Control litters (1.56 ± 0.03 kg) was observed when compared with low TB Early-Arg litters (1.40 ± 0.04 kg). Offspring from Average TB litters had similar (P > 0.05) BiWt when compared with low and high TB litters for Early-Arg (1.4 vs. 1.4 and 1.3, respectively), Full-Arg (1.4 vs. 1.5 and 1.3, respectively), and Late-Arg (1.4 vs. 1.4 and 1.3, respectively) treatments (Fig. 2), whereas a greater difference was observed in BiWt of Control pigs from high (1.2), average (1.3), and low (1.6) TB litters, respectively (±0.03; P < 0.01).

No Significant Effect of Arg Supplementation During Gilt Gestation Was Observed on Sow Retention Rate

Of gilts placed on trial, 86.7%, 83.0%, 83.6%, and 78.2% completed gestation and farrowed for Control, Early-Arg, Full-Arg, and Late-Arg, respectively (P = 0.24). Reasons for gilt removal from the breeding group included reproductive failure, lameness, prolapse, or death. Of those gilts that completed gestation and the entire treatment period, retention to P3 was 75.5%, 78.1%, 69.6%, and 73.6% (P = 0.43), indicating a fallout rate of 24.5%, 21.9%, 30.4%, and 26.4% for Control, Early-Arg, Full-Arg, and Late-Arg, respectively (Fig. 3).

No Significant Effect of Arg Supplementation Was Observed on Subsequent Gilt Reproductive Performance

Sow performance improved with increasing parity; however, no significant effect of maternal

Table 4. Effect of maternal supplementation of 1% Arg on first parity litter performance

	Treatment[1]					
Parameter	Control	Early-Arg	Full-Arg	Late-Arg	SEM[2]	*P*-value
Total born	14.3	14.3	14.2	14.4	0.2	0.96
Born alive (BA)	13.2	12.8	12.9	13.3	0.2	0.37
Stillborn (SB)	0.8	1.0	0.9	0.7	0.1	0.32
Mummified	0.4	0.5	0.3	0.3	0.1	0.29
Number of males	7.3	7.2	7.3	7.5	0.2	0.84
Male, birth weight, kg	1.36	1.39	1.39	1.37	0.02	0.42
Number of females	6.5	6.5	6.5	6.6	0.2	1.00
Female, birth weight, kg	1.28	1.32	1.31	1.29	0.02	0.41
BA birth weight, kg	1.35	1.38	1.39	1.35	0.02	0.20
BA weight variation[3], kg	0.06	0.05	0.06	0.06	<0.01	0.73
Weight (BA and SB), kg	1.33	1.36	1.36	1.33	0.02	0.33
BA + SB weight variation[3], kg	0.07	0.06	0.07	0.07	<0.01	0.89
Number pigs weaned[4]	11.6	11.7	11.5	11.4	0.3	0.90
Prewean mortality (%)	11.5	10.2	12.4	12.2	1.5	0.64

[1]Control (n = 143; 0% supplemental L-Arg); Early-Arg (n = 138; 1% supplemental Arg 15 to 45 d of gestation); Full-Arg (n = 139; 1% supplemental Arg 15 d of gestation until farrowing); and Late-Arg (n = 128; 1% supplemental Arg 85 d of gestation until farrowing).

[2]Maximum value of standard error of the mean.

[3]Variance (an average of squared differences from the mean, $\sum (x - X)^2/(n - 1)$) was calculated utilizing offspring within each litter to gain litter variance for sow. Variances for each sow litter were then statistically analyzed to evaluate trends related to each treatment.

[4]Number of pigs weaned.

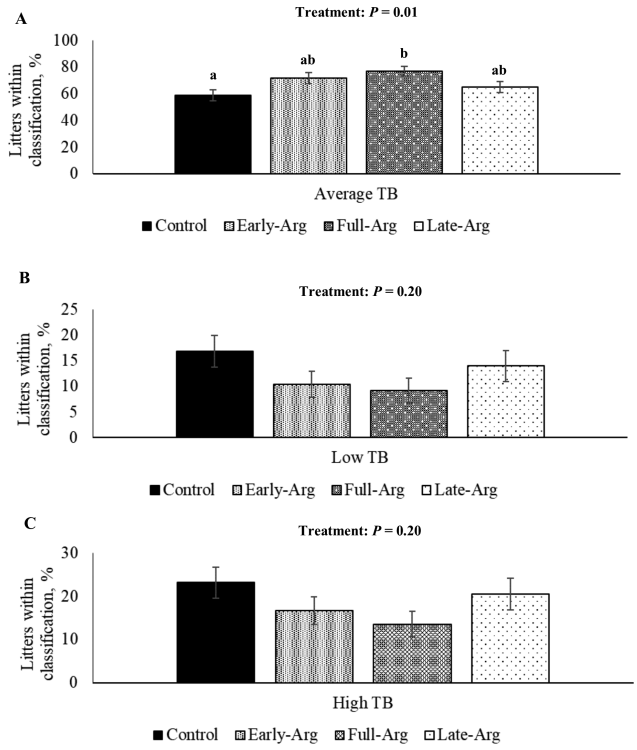

Figure 1. Percentage of litters produced by sows receiving 1% supplemental Arg during P0 gestation in each of the total born (TB) classifications. (A) The percentage of litters with an average litter size (12 to 16 TB) was increased among sows in the Full-Arg treatment, when compared with the Control. (B) The percentage of sows with low litter size (<12 TB) was not different across maternal dietary treatment. (C) Percentage of litters with a high litter size (>16 TB) was not different across maternal dietary treatment. Differing superscripts indicate $P \leq 0.05$.

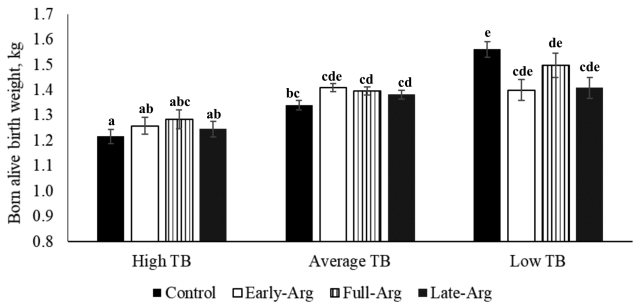

Figure 2. Effect of litter size on average birth weight of offspring from sows receiving 1% supplemental Arg during P0 gestation. Interaction of maternal diet and litter size ($P < 0.01$) shows increased similarity in birth weights of offspring across litter size class from sows supplemented with Arg during gestation, when compared with the Control. As evidenced by an increase in similarity of values in Early-Arg, Full-Arg, and Late-Arg across high (>16), average (12 to 16), and low (<12) total born (TB) litter size classifications. Differing superscripts indicate $P \leq 0.10$.

dietary treatment during P0 gestation was observed on subsequent reproductive performance. Average TB (Fig. 4A) increased ($P < 0.01$) from P1 to P3, regardless of maternal dietary treatment (Fig. 4B). However, BA was decreased ($P = 0.03$) over all parities from sows in the Early-Arg maternal diet group (13.0), when compared with the Control maternal diet group (13.7; $P = 0.02$). Maternal dietary treatment did not affect WEI ($P = 0.71$) for services between P1 and P2 or for services between P2 and P3 for sows remaining in production (Fig. 4).

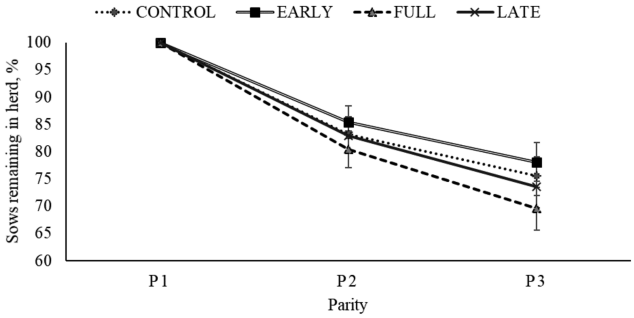

Figure 3. Retention rate of sows receiving 1% supplemental Arg during P0 gestation to P3 of commercial production. All sows serviced at the start of the trial were included. All gilts that completed the dietary treatment and achieved P1 status were included at the measured P1 retention and utilized to measure retention through subsequent parities. No differences were observed in retention rate × treatment interaction ($P > 0.43$).

DISCUSSION

Maternal Arg supplementation during gestation purportedly increases litter size in gestating gilts (Mateo et al., 2007), as well as improves fetal weight and offspring BiWt (Wu et al., 2013). Approximately 40% of dietary Arg is thought to be utilized by the small intestine (Wu et al., 2005), suggesting that additional Arg could improve its availability for extra-intestinal use. This experiment was designed to investigate the effect of supplementing L-Arg during gilt gestation within a commercial swine production system. Arginine was supplemented at 1% in this experiment due to observed benefits of Arg supplementation at 0.83% to 1% in gestation diets of previous studies (Mateo et al., 2007; Gao et al., 2012); additional arginine supplementation resulting in 1.28% total Arg in the treatment diet. However, results of this project do not support the hypothesis that Arg supplementation to gilts during specific stages of P0 gestation improves reproductive ability, as assessed by litter characteristics and subsequent reproductive performance.

In comparison to existing literature, the timing of Arg supplementation across studies is variable with respect to gestation stage. Improvements in litter size in commercial swine genetics is associated with increased mortality in embryonic, fetal, and preweaning phases of growth, regardless of energy or protein differences in gestation diets (Kraeling and Webel, 2015). Ovulation rates, which have been improved through genetic selection (Johnson et al., 1999), further compound the already high embryonic and prenatal mortality in pigs, which is estimated to range from 30% to 50% (Pope, 1994). Prenatal mortality occurs primarily during the peri-implantation period and again when uterine

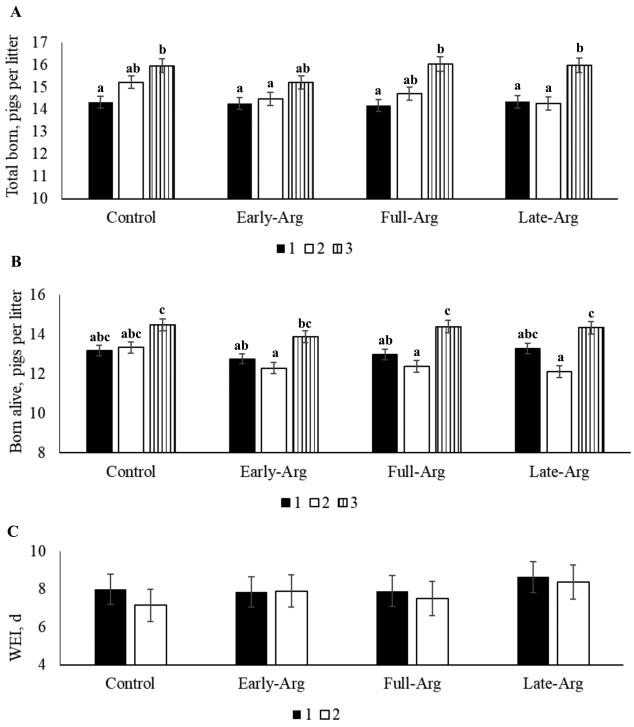

Figure 4. Reproductive performance of sows that received 1% supplemental Arg during P0 gestation through P3. (A) Number of total born was significantly affected by parity although was not influenced by maternal treatment or the interaction of maternal dietary treatment by parity (Treatment, $P = 0.19$; Parity, $P < 0.01$; Treatment × Parity, $P = 0.35$). (B) Number of offspring born alive per maternal treatment across parities (Treatment, $P = 0.03$; Parity, $P < 0.01$; Treatment × Parity, $P = 0.35$). Over all parities, average number of offspring born alive was increased in litters from the P1 Control maternal dietary treatment when compared with litters from the Early-Arg maternal dietary treatment ($P = 0.02$); Full-Arg and Late-Arg maternal dietary treatments were not different. This decrease may be related to timing of service from P1 to P2, as it was during late July to September of 2016, a time that is typically related to seasonal reduction in reproductive performance. (C) Wean-to-estrus interval (WEI) for services from P1 to P2 and services from P2 to P3 (Treatment, $P = 0.71$; Parity, $P = 0.52$; Treatment × Parity, $P = 0.96$). Maternal dietary treatment during P0 gestation did not affect maternal WEI. Different superscripts indicate significant ($P \leq 0.05$) differences.

capacity becomes limiting (around days 30 to 40 of gestation; Anderson, 1978; Wilson, 2001). The ability of the developing fetus to survive when uterine capacity becomes limited is related to the surface area of placental attachment to the uterine endometrium, as the mechanism for increasing placental nutrient uptake in domestic European swine breeds is through increasing placenta size (Knight et al., 1977; Vonnahme et al., 2001). In the current experiment, an increased percentage of average litter sizes from sows supplemented with Arg was observed for litters from Full-Arg treatment (day 15 to farrowing). Average litter size in this herd was also reported at 14 TB per sow, indicating that litter size performance of the herd may already be approaching uterine capacity; if this is the case, beneficial expression of Arg supplementation

may be suppressed by physical capacity of the reproductive tract.

Arginine is a precursor molecule for endogenous synthesis of specific and metabolically necessary signaling proteins such as creatine, ornithine, and nitric oxide (Urschel et al., 2007; Puiman et al., 2011). This makes Arg an important contributor to embryonic and placental development. Acting specifically as a regulator of cell proliferation, Arg enables the release of GATOR proteins from CASTOR proteins, allowing for activation of protein synthesis and cellular proliferation through mTORC1 (Chantranupong et al., 2016). This supports existing evidence that Arg supplementation improves growth of porcine trophectoderm, a critical component of placenta formation (Gao et al., 2012; Kong et al., 2012; Wang et al., 2014). Improved trophectoderm cell proliferation and subsequent placental development during the establishment of the fetal–maternal interface is considered a mechanism through which Arg may contribute to increased litter size and birth weight. However, the effect of Arg supplementation on litter size is inconsistent (Bérard and Bee, 2010; Quesnel et al., 2014; Garbossa et al., 2015; Dallanora et al., 2017; Madsen et al., 2017).

Increased litter size is associated with decreased birth weight, a common artifact of intrauterine growth restriction (**IUGR**; Muns et al., 2016). Utilizing supplemental Arg during gestation has been previously suggested as a possible mitigation strategy for IUGR-induced embryonic mortality and low birth weight (Foxcroft et al., 2009; Oksbjerg et al., 2013). A significant decrease in SB piglets was observed by Mateo et al. (2007) when sows were supplemented with L-Arg, suggesting fetal survivability in late gestation was improved. Arginine levels in fetal fluids have been observed to decrease over the course of gestation (Wu et al., 1995), suggesting that fetal Arg demand increases as gestation progresses. In this experiment, however, no benefits of Late-Arg (day 85 to farrowing) were observed in retention or number of pigs weaned, indicating that additional Arg during a period of high nutritional demand did not improve the number of pigs weaned per sow.

Commercial swine gestation diets are typically formulated to meet the minimum requirements of growth-limiting AA, with little regard to excesses of AA. Arginine content is relatively high in corn, dried distillers grains with solubles, and soybean meal (NRC, 2012). Although swine diets are largely formulated based on AA ratios, CP levels for gestation diets were recommended to be kept between 12% and 13% (NRC, 1998). Due to the shift in focus from CP to AA, it is common for CP levels in commercial sow diets to be in excess of 13% and some suggest that this increase in dietary nitrogen load may limit the effectiveness of Arg on placental development and embryo survival (Ji et al., 2017; Wu et al., 2017). Supporting this posit, previous trials with diets formulated to contain approximately 12% CP observed that Arg supplementation improved litter size (Dellavalle et al., 2007; Mateo et al., 2007, 2008). Data from the current experiment and others did not observe an increase in litter size when supplemental Arg was supplied in combination with CP levels > 13% in the diet (Quesnel et al., 2014; Garbossa et al., 2015; Bass et al., 2017; Dallanora et al., 2017). Even still, some studies have observed improved offspring birth weights with Arg supplementation despite CP levels > 13% (Bérard and Bee, 2010; Gao et al., 2012). Reasons for the inconsistencies are not clear, but the interaction between supplemental Arg and dietary CP coupled with litter size influences that interaction and requires more investigation.

In the current trial, the hypothesis that dietary supplementation of 1% L-Arg supplied to gilts in a commercial production setting during specific stages of P0 gestation would improve reproductive capacity as assessed by litter characteristics and subsequent reproductive performance was tested. Data from this study indicate that the additional 1% L-Arg, equal to 25 g/d or 1.28% of diet, did not provide benefits to sow reproductive performance at P0 or in subsequent performance to P3. All other reproductive performance parameters indicate that Arg supplementation during gestation provided no benefits or detriments to sow performance.

Overall, these data suggest that maternal dietary supplementation of 1% Arg during gestation had little, if any, impact on reproductive performance in P1 commercial sows. Based on this data, no physiological advantage is observed for utilizing Arg supplementation during gestation to improve reproductive performance of P0 sows. These data, taken together with existing literature, demonstrate the biological complexity of nutritional Arg supplementation to influence reproductive performance. Thus, this underscores the need for a better understanding of how AA can be utilized to optimize fetal development and sow reproductive performance in commercial production systems.

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