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INFLUENCE OF PORCINE PLASMA SUPPLEMENTATION ON GESTATING SOW SERUM IGF-1 CONCENTRATION AND LITTER WEIGHTS

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Abstract

The objective of this pilot study was to determine the effect of dietary porcine plasma on circulating insulin-like growth factor 1 (IGF-1) concentrations in gestating sows and characteristics of their litters. Primiparous and multiparous sows were randomly allocated to two treatment groups of sows fed a basal diet or sows fed the basal diet plus 6 g of porcine plasma throughout gestation. On 4 periods during gestation and farrowing, blood was collected for IGF-1 analysis. After farrowing, gestation length, number born, birth weight, and total litter weight were recorded. There were no three-way or two-way interactions between treatments, day of gestation, or parity for sow IGF-1 concentration (P>0.142). Treatment also did not affect (P=0.117) sow IGF-1 concentration. There were no treatment × parity or treatment effects on litter measures (P=0.170). Feeding porcine plasma at the low level employed in the study did not improve sow IGF-1 or litter measures.

Keywords: Piglets, Fetal Growth, Porcine Plasma

Introduction

Selection for hyperprolific sows has increased litter size over the past two decades (Fix et al., 2010) and simultaneously increased birth weight (BW) variation among litters (Milligan et al., 2002). In litters of 11 piglets, 7% of piglets are classified as low birth weight, and as litter size increases up to 23% of piglets are classified as low birth weight (Fix et al., 2010). Piglets within litters that lie beneath the 10th percentile are classified as small for gestational age (SGA). Piglets that are classified as SGA experience survivability and low postnatal production efficiency problems that negatively impact the pork industry's profitability and raise welfare issues (Wollmann, 1998; Mamelle et al., 2001; De Vos et al., 2014).

The use of spray-dried porcine plasma has been utilized in various segments of early pig production. In the nursery phase, porcine plasma improves average daily gain (ADG) and gain to feed ratio (G:F) from d 0 to 14 post-weaning (Coffey and Cromwell, 1995; De Rodas et al., 1995; Everts et al., 2001). The mode of action for plasma effects on growth is not known; however, De Rodas et al. (1995) found that piglets supplemented with plasma had greater plasma GH concentrations than piglets only fed a standard corn/soybean diet. Crenshaw et al. (2007) reported that plasma supplementation of lactating sows improved litter productivity during the lactation period. While there have not been many studies documenting the effects of porcine plasma on pig BW measures, there is interest in utilizing porcine plasma to increase the average piglet BW. Campbell et al. (2006) reported that 0.5% dietary spray-dried plasma increased farrowing rate; increased pigs born alive, and increased number of pigs weaned in a commercial herd with a history of porcine reproductive and respiratory syndrome virus. Therefore, the objectives of this study were to determine the effects porcine plasma supplementation to gestating sows on maternal circulating IGF-1 concentration and litter characteristics.

Literature Review

Spray-dried plasma is a common feed supplement fed to pigs during various stages of early pig development. Coffey and Cromwell (1995) completed a series of experiments to first determine the appropriate level to supplement porcine plasma for nursery pigs, and compared feed ADG, G:F, and feed intake to pigs being supplemented with spray dried porcine plasma, dried skim milk, and a soybean meal. Authors observed that pigs that were supplemented with spray dried porcine plasma experienced greater ADG compared to pigs supplemented with soybean meal and dried skim milk. Additionally, pigs supplemented with spray dried porcine plasma had increased daily feed intake compared to pigs supplemented with soybean meal or dried skim milk. In one of their experiments pigs were fed in an experimental nursery that had fewer pigs and improved climate control compared to a conventional nursery. It is interesting that the impact of spray dried porcine plasma on ADG and feed intake was greater for pigs in a conventional nursery compared to the experimental nursery. This study illustrates that supplementation of spray dried plasma to nursery pigs effectively stimulates ADG through and increase in feed intake, but provides little insight into its impact on growth metabolites.

Another study conducted by de Rodas et al. (1995) was aimed at determining the mode of action in which spray-dried porcine plasma improves ADG and feed intake in nursery pigs. Similar to the previous study discussed ADG and feed intake was increased for the first 14 days in the nursery. The plasma concentrations of insulin, IGF-1, growth hormone, and glucose were also evaluated. The plasma concentrations of IGF-1 and glucose were not affected by spray dried porcine plasma supplementation. Pigs that were supplemented with spray dried porcine plasma tended to have elevated levels of plasma growth hormone and decreased levels of insulin compared to pigs supplemented with soybean meal. In conjunction, these two studies indicate that spray dried porcine plasma can effectively improve growth performance nursery pigs through an increase in daily feed intake and partial stimulation of the somatotropic axis.

Crenshaw et al. (2007) supplemented lactating sows with spray-dried porcine plasma to evaluate parameters involved in sow productivity and litter characteristics. Young sows (parity 1 and 2) that were supplemented with spray-dried porcine plasma had increased feed intake and decreased weight loss during lactation. In contrast mature sows (parity > 3) had decreased feed intake when they were supplemented with spray-dried porcine plasma. Interestingly, the weaning to estrus interval was improved in both young and mature sows. Litters from mature sows that were supplemented with spray-dried porcine plasma had an increased number of marketable pigs weaned and a greater average litter weights compared to sows that were not supplemented with spray dried porcine plasma.

The current literature has evaluated the effects of porcine plasma on young pigs; however, there has been little research conducted regarding the effects of porcine plasma on fetal development of pigs. Campbell et al., (2006) conducted a statistical process control analysis on supplementation of spray-dried plasma on gestating sows from a herd with a history of porcine reproductive and respiratory syndrome virus with porcine plasma at a rate of 0.5% of the diet and observed an increased farrowing rate, more pigs born alive, and increased number of pigs weaned. This report provides evidence that supplementation of porcine plasma can positively benefit swine production when supplemented during gestation, but does not define the mode of action in which porcine plasma elicits its response.

Materials and Methods

Animals

Experimental procedures were approved by the Institutional Animal Care and Use Committee at Kansas State University. Multiparous (previously farrowed one to three litters; n = 16) and primiparous (not previously farrowed; n = 10) were randomly allotted within parity to two treatment groups, basal diet (CON) and basal diet supplemented with porcine plasma (PP). Supplemented sows received 6 g top-dress of porcine plasma in their daily feed from d 6 of gestation (d 0=onset of estrus). Sows were fed once per day (08:00) 2.3 kg•animal^{-1}•d^{-1}of the gestation diet until d 100 ± 3 of gestation after which feed was increased to 3.2 kg•sow^{-1}•d^{-1} (Table 1). Beginning on d 106 ± 3 of gestation sows were fed 1.4 kg•animal^{-1}•d^{-1}of the standard KSU lactation diet twice daily until parturition. Approximately 24 to 36-hours postpartum, pigs were weighed individually and ear notched. Gestation length, number of pigs farrowed, and litter weight of live pigs were also recorded for each sow.

Table 1. Composition (as fed basis) of diets fed to sows during gestation[1]

Ingredient, %	Gestation	Lactation
Corn	80.2	63.0
Soybean meal	15.6	30.2
Choice white grease	0.00	2.50
Calcium	1.48	1.48
Limestone	1.15	1.10
Sodium chloride	0.50	0.50
L-lysine hydrochloride	0.00	0.20
DL-methionine	0.00	0.05
L-threonine	0.03	0.08
Trace mineral premix	0.15	0.15
Sow add pack	0.50	0.50
HiPhos 2700	0.02	0.02
Vitamin premix	0.25	0.25

[1]Sows were fed 2.3 kg•animal^{-1}•d^{-1}of the gestation diet until d 100 ± 3 of gestation after which feed was increased to 3.2 kg•animal^{-1}•d^{-1}. On d 106 ± 3 of gestation sows were fed 1.4 kg•animal^{-1}•d^{-1}of the standard KSU lactation diet twice daily until parturition. The sows in the porcine plasma treatment had approximately 6 g of the diet replaced with porcine plasma.

Blood and Body Weight Collection

Pre-treatment blood and body weight were collected on d 5 of pregnancy to serve as a baseline for serum IGF-1 concentration. These measures were also collected on d 40, d 90, and within 36 h after farrowing. Blood was collected by jugular vein puncture with a BD Vacutainer® (BD, Franklin Lakes, NJ, USA) and serum was harvested as described (Tuck et al., 2009). Briefly, blood samples were placed on ice immediately after collection, incubated for 30 min at room temperature to allow the blood to clot sufficiently, and serum was separated by centrifugation (1500 × *g*) for 25 min at 4°C and was stored frozen (-80°C) until analysis.

Serum Analysis

Serum samples were assayed in triplicate using a human IGF-1 ELISA kit (ENZO Life Sciences, Farmingdale, NY). Optimal concentration of porcine serum used for analysis was determined by conducting a standard dilution curve and identifying sample concentrations that were near the middle of the linear portion of the dilution curve. The assay was validated for parallelism and recovery of added mass as described by Balaji et al. (2000). Parallelism was determined by using volumes of extract ranging from 25 µL to 100 µL. Volume corrected concentrations of IGF-1 were regressed on the volume of extract and produced a regression line with a slope that had a 95% confidence interval to include 1.0. Human IGF-1 standard was also recovered quantitatively when added to porcine IGF-1 samples. The limit for detection of this kit was 6 ng/mL.

The assay measured total bound and unbound IGF-1 and Serum was mixed (1:5) in acidic ethanol (ethanol: 2N HCl, 7:1) and incubated 30 min to separate IGF-1 from IGF binding proteins. Binding proteins were precipitated by centrifugation (9,900 × *g*) for 5 min at room temperature. Supernatant was removed and neutralized with an equal volume of neutralizing reagent. Samples were diluted 1:35 in assay buffer. Diluted samples (100 µL) were added to pre-coated IGF-1 ELISA plates and incubated for 1 h. This and subsequent incubations were conducted on a shaker (500 rpm) at room temperature. The ELISA plate was rinsed 5 times with 200 µL of wash buffer, and blotted on lint free paper towels after each rinse. After rinsing, 100 µL of primary IGF-1 antibody was added to the wells in the ELISA plate and incubated for 2 h. Residual primary antibody on the plate was rinsed and blotted as described above. Blue conjugate (100 µL) was added to each well and incubated for 30 min. After incubation the ELISA plate was rinsed and blotted to remove residual blue conjugate. One hundred microliters of substrate solution was added and incubated 30 min, 100 µL of stop solution was added to each well, and sample absorbance measured at 450 nm using a BioTek EON spectrophotometer (BioTek, Winoski, VT). Concentrations were calculated based on absorbance values from a standard curve of known concentrations using Gen5 data analysis software (BioTek).

Statistical Analysis

The concentrations of IGF-1 in serum were analyzed as a randomized design with a 2 × 2 factorial arrangement, utilizing repeated measures with sow as the experimental unit. The fixed effects included treatment, parity, day of blood collection, and all interactions. The random effect included sow within parity and day 5 serum IGF-1 concentration was used as a covariate. Day served as the repeated measure, with sow as the subject, and compound symmetry as the covariance structure. Analysis of body weight and backfat was conducted similar to the serum IGF-1 concentration data without the covariate. The second analysis was performed by first calculating the percent change from day-5 measures for serum IGF-1, bodyweight, and backfat. Data were analyzed as a randomized design with a 2 × 2 factorial arrangement and sow as experimental unit. Fixed effects were treatment, parity, and the treatment × parity interaction.

Litter data were analyzed as a randomized design in a 2 × 2 factorial arrangement and sow as experimental unit. Fixed effects were treatment, parity, and treatment × parity. The random effect was sow within parity. All statistical analyses were performed using the MIXED Procedures of SAS 9.3 (Cary, NC). Pair-wise comparisons between the least square means of the factor levels, including planned interaction comparisons, were computed using the PDIFF option

of the LSMEANS statement. Differences were considered significant at $\alpha \leq 0.05$ and tendencies at $\alpha \leq 0.10$

Results

There were no three-way or two-way interactions for serum IGF-1 concentration ($P > 0.142$, Table 2, shown in the Appendix). Throughout the course of the study, sow total serum IGF-1 concentration decreased ($P < 0.001$) for all sows. Parity influenced overall serum IGF-1 concentration, with primiparous sows possessing greater ($P < 0.001$) serum IGF-1 than multiparous sows. Inclusion of the porcine plasma product in the diet did not affect ($P = 0.117$) serum IGF-1 levels.

There were no parity × treatment × day, parity × treatment, or treatment × day interactions ($P > 0.156$) for sow body weights. There was a parity × day interaction ($P < 0.001$) for body weight. Primiparous sows weighed less than multiparous sows on all days ($P < 0.001$). All sows in the experiment increased ($P < 0.001$) in body weight over the course of the trial and multiparous sows weighed more ($P < 0.001$) than primiparous sows over the experiment. Inclusion of the commercial plasma product in the diet of the sows did not influence ($P = 0.559$) body weight. . There was a parity × day interaction ($P = 0.024$) for sow backfat. Primiparous sows had more backfat than multiparous sows on day 40 post-estrus and at farrowing ($P < 0.026$), but both parities had similar backfat on the other days ($P > 0.369$). Other interactions did not ($P > 0.513$) affect backfat. Over the entire course of the study, treatment did not affect ($P = 0.983$) backfat, and backfat increased ($P < 0.001$) as day of gestation increased.

Data were also analyzed as a percent change from the initiation of the trial (Table 3, shown in the Appendix). There were no parity × treatment interactions for changes in serum IGF-1 concentrations at any of the sampling days ($P > 0.144$). Multiparous sows experienced a greater decline in serum IGF-1 concentrations compared to primiparous sows on all sampling days ($P < 0.054$). Treatment did not affect the percent change of serum IGF-1 concentration on day-90 and at farrowing ($P > 0.181$); however, sows supplemented with porcine plasma tended to have less ($P = 0.098$) decrease in serum IGF-1 concentrations at day-40. There were no parity × treatment interactions for percent body weight change ($P > 0.629$). Primiparous sows gained more weight than multiparous sows at all weigh dates ($P < 0.001$). Body weight change for the first and second period of the trial was not different among treatments ($P > 0.103$). Sows supplemented with porcine plasma tended to gain less ($P = 0.080$) weight from the initiation of the trial to farrowing. There were no parity × treatment interactions for change in backfat over the course of the study ($P > 0.243$). Backfat increase tended to be greater ($P = 0.061$) for primiparous sows at day-40 than multiparous sows; however, backfat change was not different among parities at day-90 or farrowing ($P > 0.131$). Over the duration of the study, porcine plasma did not affect backfat measures ($P > 0.248$).

Upon farrowing, gestation length and litter parameters were recorded (Table 4, shown in the Appendix). There were no parity × treatment interactions, parity effect, or treatment effects on gestation length and litter size ($P > 0.113$). There were no parity × treatment interactions or treatment effects for total litter weight and average piglet BW ($P > 0.170$); however, parity did

affect these two measures with multiparous sows having litters and individual piglets that weighed more than those from primiparous sows ($P < 0.018$).

Discussion

To date, a limited amount of research exists on the impact of porcine plasma on fetal development. One of the objectives of the current study was to increase maternal IGF-1 levels through the supplementation of dietary porcine plasma. While the utilization of plasma products to increase maternal IGF-1 concentrations have not been adequately explored, gestating sow IGF-1 levels have been manipulated through the use of porcine somatotropin administration. When supplemented during late gestation, porcine somatotropin increases maternal IGF-1 concentration and fetal growth (Rehfeldt et al., 2004). The increased growth in response to porcine somatotropin and its associated IGF-1 response can also selectively increase birth weight of the smaller pig fetuses (Kuhn et al., 2004). In a poultry model, direct injection of IGF-1 into duck embryos increased weight (Wang et al., 2012). Therefore, there is a potential for elevated maternal IGF-1 concentration to affect fetal development. As illustrated in Figure 1 (Shown in the Appendix), serum IGF-1 concentrations were greatest at day-5 post estrus and dropped 66% to their lowest levels at day-90 post-estrus. At the time of farrowing, serum IGF-1 concentrations increased from day-90, but on average were still 23% less than serum IGF-1 concentrations on day-5 of pregnancy. Maternal hepatic IGF-1 status over the course of gestation has not adequately been characterized in swine. Lee et al. (1993) reported that IGF-1 concentrations in the mammary glands follow a pattern similar to the serum concentrations in the current study, with levels reaching their lowest point at day-90 post estrus and increasing through farrowing. Therefore, these data reveal the gestating sow's IGF-1 secretory pattern.

The current study did not detect increased circulating maternal IGF-1 concentrations or effects on litter measurements due to porcine plasma supplementation. There was, however, a tendency for Porcine Plasma (PP) sows to have the smallest reduction in IGF-1 at day 40 of gestation, numerically maintain the greatest serum IGF-1 levels throughout gestation, and increase in IGF-1 over day 5 levels at farrowing. The average litter weights would indicate that the product may increase piglet weight to a greater extent in the primiparous sows. Whether these differences would result in significant differences with greater numbers of sows will require additional experiments beyond this this pilot project. Another consideration is the amount of plasma product supplemented. Crenshaw et al. (2007) conducted a series of studies evaluating the impact of feeding plasma to lactating sows in a commercial setting. In the first 3 experiments, there were no effects of supplementing spray dried plasma on sow or litter performance when plasma was included at 0.25% of the diet. This level is similar to supplementation levels utilized in the current study. In their fourth study authors increased supplementation to 0.50% and observed increased feed disappearance, and more piglets that had a greater average body weight at weaning. They did not measure serum IGF-1, but when feed intake is increased, serum IGF-1 and IGFBP3 levels are increased (Rehfeldt and Kuhn, 2006). Therefore, porcine plasma supplementation may be capable of augmenting the IGF axis through increases in feed intake. This mechanism was not possible in the present study because feed availability was restricted and did not differ between treatments. The data of Crenshaw et al. (2007) indicate a possible mechanism by which porcine plasma supplementation may increase circulating maternal IGF-1 and enhance litter measurements.

Another interesting finding of the current study was the large differences in most measures between parities. Gatford et al. (2013) suggested that primiparous sows may be more susceptible to alterations in maternal nutrition due to the increased amount of nutrients needed for maternal growth, thus competing with fetal development. In the current study, the physiological limitations of primiparous sows to allocate nutrients to both growth and gestation are apparent. Multiparous sows had 21% greater total litter weights and 14% greater individual birth weights than primiparous sows. Primiparous sows gained more weight across the course of gestation and had 30% greater serum IGF-1 concentrations, which could indicate nutrients were more directed toward maternal growth. This hypothesis is supported by a trend for piglets from primiparous sows to exhibit a greater amount of brain sparing by having 10% greater brain to body weight ratio than piglets from multiparous sows (unpublished data). Therefore, sows of different ages may differ in their physiological response to treatments affecting fetal development. In light of these considerations, the primiparous sows' response to the PP discussed above may indicate that PP is more effective in this class of sows.

Conclusion

The current pilot study demonstrated that supplementing a commercial plasma product during gestation did not affect piglet birth weight, which may be explained by the absence of an IGF-1 response in maternal serum. Based on the physiological differences in parities of sows, it is important to identify the optimal supplementation strategy for primiparous and multiparous sows separately. Further research will be needed to determine an appropriate supplementation level of this porcine plasma product needed to elicit a beneficial response on the IGF axis, and potentially, result in improvements fetal development.

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Appendix

Table 2. Circulating serum IGF-1 concentration, body weight, and backfat depth from primiparous and multiparous sows supplemented with or without porcine plasma during gestation

	Primiparous		Multiparous			*P*-value						
Treatment[1]	CON	PP	CON	PP	SEM	Parity × Trt[2] × Day	Parity × Trt	Parity × Day	Trt × Day	Parity	Day	Trt
	n = 6	n = 4	n = 7	n = 9	-	-	-	-	-	-	-	-
Serum IGF-1, ng/mL												
D5	151.33	136.87	132.60	141.29	14.84	0.314	0.263	0.142	0.473	<0.001	<0.001	0.117
D40	95.96	124.07	56.70	60.83	14.84							
D90	50.49	71.19	35.45	31.52	14.84							
Farrowing	102.59	157.86	82.09	84.69	14.84							
Body weight, kg												
D5	150.07	161.27	218.56	227.72	9.64	0.940	0.831	<0.001	0.156	<0.001	<0.001	0.559
D40	169.02	175.82	218.06	223.79	9.64							
D90	201.75	204.30	247.99	248.17	9.64							
Farrowing	220.97	223.85	271.54	267.38	9.64							
Backfat, mm												
D5	14.08	13.75	13.00	13.78	1.05	0.513	0.999	0.024	0.666	0.123	<0.001	0.983
D40	15.83	16.25	13.43	13.44	1.05							
D90	16.33	15.50	15.14	14.78	1.05							
Farrowing	18.42	19.25	16.57	16.22	1.05							

[1]CON = sows fed the control dietary regimen only. PP = sows fed the control dietary regimen plus 6 g of porcine plasma daily. Sows were fed 2.3 kg•animal^{-1}•d^{-1} of the gestation diet until d 100 ± 3 of gestation after which feed was increased to 3.2 kg•animal^{-1}•d^{-1} (Table 1). On d 106 ± 3 of gestation sows were fed 1.4 kg•animal^{-1}•d^{-1} of the standard KSU lactation diet twice daily until parturition. Supplementation of porcine plasma was initiated 6 days post-estrus.

[2]Trt = treatment main effect.

Table 3. Percent change in sow serum IGF-1 concentrations, body weight, and backfat from primiparous and multiparous sows supplemented with or without porcine plasma during gestation

	Treatment[1]							
	Primiparous		Multiparous			*P*-value		
	CON	PP	CON	PP	SEM	Parity × Trt[2]	Parity	Trt
D5 - D40[3]								
Serum IGF-1, ng/mL	-35.26	-6.67	-57.80	-52.26	12.07	0.256	0.002	0.098
Body weight, kg	12.72	9.09	0.24	-1.40	2.47	0.629	<0.001	0.207
Backfat, mm	13.14	18.17	5.93	-0.02	8.39	0.365	0.061	0.850
D5 - D90[4]								
Serum IGF-1, ng/mL	-64.06	-45.42	-74.68	-75.16	8.03	0.160	0.006	0.181
Body weight, kg	34.73	26.87	14.48	9.51	4.59	0.704	<0.001	0.103
Backfat, mm	18.79	13.41	18.47	7.74	8.29	0.697	0.664	0.248
D5 – farrowing[5]								
Serum IGF-1, ng/mL	-27.59	17.47	-36.05	-40.00	19.77	0.144	0.054	0.217
Body weight, kg	47.51	39.00	25.49	18.07	5.30	0.900	<0.001	0.080
Backfat, mm	32.91	40.97	29.95	18.72	9.81	0.243	0.131	0.845

[1]CON = sows fed the control dietary regimen only. PP = sows fed the control dietary regimen plus 6 g of porcine plasma daily. Sows were fed 2.3 kg•animal^{-1}•d^{-1}of the gestation diet until d 100 ± 3 of gestation after which feed was increased to 3.2 kg•animal^{-1}•d^{-1} (Table 1). On d 106 ± 3 of gestation sows were fed 1.4 kg•animal^{-1}•d^{-1}of the standard KSU lactation diet twice daily until parturition. Supplementation of porcine plasma was initiated 6 days post-estrus.

[2]Trt = treatment main effect.

[3]Data represents the values from day-40 post-estrus divided by the values from day-5 post-estrus and multiplied by 100.

[4]Data represents the values from day-90 post-estrus divided by the values from day-5 post-estrus and multiplied by 100.

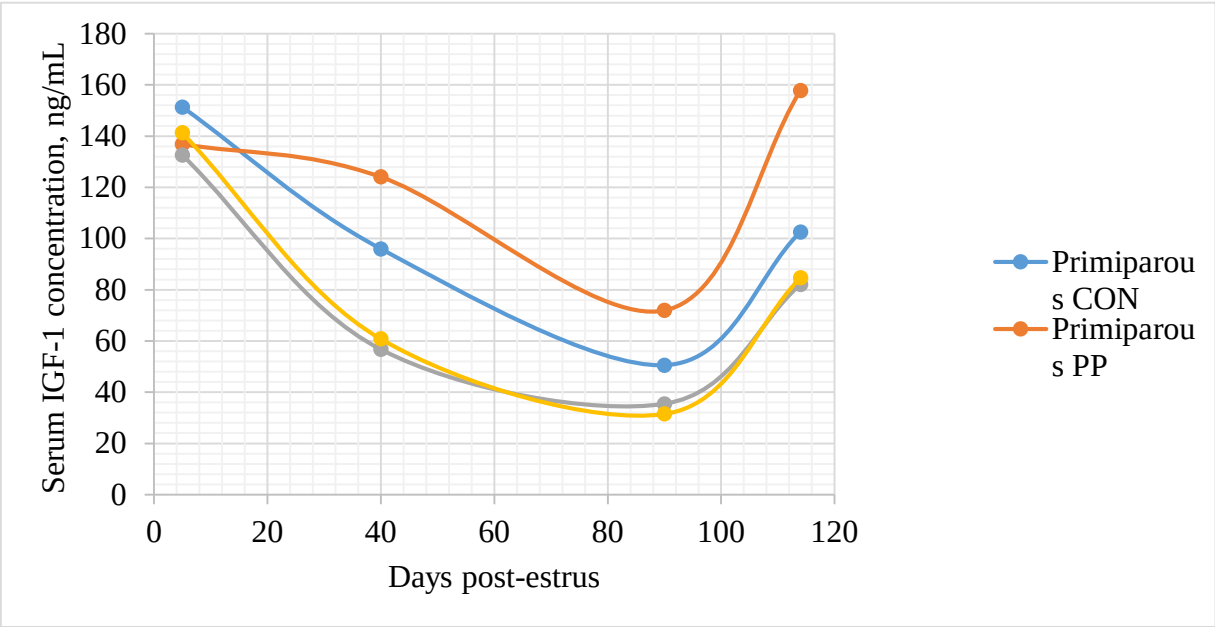
[5]Data represents the values from farrowing divided by the values from day-5 post-estrus and multiplied by 100.

Table 4. Gestation length, litter size, average piglet weight, and total litter weight from primiparous and multiparous sows supplemented with or without porcine plasma during gestation

	Primiparous		Multiparous			*P*-value		
Treatment[1]	CON	PP	CON	PP	SEM	Parity*Trt[2]	Parity	Trt
Gestation Length, days	114.33	115.00	115.14	115.28	0.50	0.762	0.113	0.205
Litter Size	12.17	11.00	13.42	11.56	1.40	0.761	0.437	0.199
Average Piglet weight, g	1,259.53	1,426.28	1,519.87	1,585.59	100.10	0.544	0.018	0.170
Total litter weight, kg	15.22	14.79	20.14	17.87	5.35	0.374	<0.001	0.196

[1]CON = sows fed the control dietary regimen only. PP = sows fed the control dietary regimen plus 6 g of porcine plasma daily. Sows were fed 2.3 kg•animal^{-1}•d^{-1}of the gestation diet until d 100 ± 3 of gestation after which feed was increased to 3.2 kg•animal^{-1}•d^{-1} (Table 1). On d 106 ± 3 of gestation sows were fed 1.4 kg•animal^{-1}•d^{-1}of the standard KSU lactation diet twice daily until parturition. Supplementation of porcine plasma was initiated 6 days post-estrus.

[2]Trt = treatment main effect.



Trt	P = 0.117
Day	P < 0.001
Parity	P < 0.001
Interactions	P > 0.142
SEM	14.84

Figure 1. Circulating serum IGF-1 concentration of primiparous and multiparous sows supplemented with or without porcine plasma during gestation. CON = sows fed the control dietary regimen only. PP = sows fed the control dietary regimen plus 6 g of porcine plasma daily. Sows were fed 2.3 kg•animal^{-1}•d^{-1}of the gestation diet until d 100 ± 3 of gestation after which feed was increased to 3.2 kg•animal^{-1}•d^{-1} (Table 1). On d 106 ± 3 of gestation sows were fed 1.4 kg•animal^{-1}•d^{-1}of the standard KSU lactation diet twice daily until parturition. Supplementation of porcine plasma was initiated 6 days post-estrus.