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Preliminary data indicate that progeny health status may improve with increasing parity.

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Summary

A preliminary experiment was conducted to investigate the health status of progeny derived from different parities; health status was characterized by evaluating the ability of P1 and P3 dams to produce and passively transfer immunoglobulins (IgA and IgG) to their progeny. At parturition, circulating concentrations of IgA and IgG were greater ($P < 0.01$) in P3 dams compared to P1 dams. As expected, during lactation, concentrations of IgA and IgG were greater ($P < 0.002$) in colostrum compared to milk (mid- and late-lactation). No parity differences were observed in immunoglobulin concentrations in colostrum or milk obtained from P1 and P3 dams. However, when immunoglobulins were quantified in the progeny of P1 and P3 dams a parity × time interaction was observed for circulating IgG ($P < 0.03$) and a trend for a parity × time interaction was observed for IgA ($P = 0.06$). Within a time point (d), serum IgG was greater ($P < 0.001$) in P3 progeny compared to P1 progeny for each time point measured. These results suggest that health status, as indicated by circulating immunoglobulin concentration, in neonatal pigs, may be affected by dam parity.

Introduction

Modern production systems have driven the need for novel techniques designed to optimize reproductive and growth performance. Segregated, all-in all-out and multisite production systems have been implemented in order to maximize the benefit of passive immunity to: decrease disease agent transmission, allow for specialized labor in each phase of production, simplify the logistics of production, maximize reproductive performance and, ultimately, optimize pig (pork) production. Anecdotal data (summarized in Table 1) suggest that P1 progeny experience reduced weaning weights, decreased nursery and finishing average daily gain (ADG) and greater mortality in the nursery and in finishing. It is generally accepted that differences observed among parities are a direct result of P1 progeny having a reduced health status compared with progeny from mature sows. Health status and differences in health status among parity are affected by complex biological factors. For example, health status may be affected by, but not limited to, exposure and susceptibility to pathogens, animal stress, and passive transfer of immunity from the dam to the neonate. However, the idea that differences exist in health status among progeny from different dam parities is not fully elucidated. Peer-reviewed, hypothesis-driven research has not been conducted to support or refute this idea. Therefore, the objective of this experiment was to begin to provide baseline information that will contribute to a greater understanding of parity health differences by evaluating the production and passive transfer of immunoglobulins (IgA and IgG) from dams of increasing parity to their progeny.

Materials and Methods

Experimental design

The experimental protocol was reviewed and approved by the Institutional Animal Care and Use Committee of the University of Nebraska–Lincoln (UNL). Dams (Large White × Landrace) included in this study were part of an ongoing sow longevity experiment currently being conducted at the UNL Swine Unit. Sows (Parity 3, P3; n = 5) included in this experiment farrowed on Sept. 26, 2006, and gilts (Parity 1, P1; n = 4) selected for inclusion in this experiment farrowed on Oct. 30, 2006. Following parturition, four to five piglets from each dam (n = 20 total progeny from each parity, P3 and P1) were randomly selected for inclusion in the analyses described below.

Laboratory analyses

To begin to ascertain the health status of progeny derived from different parities, three parameters were evaluated: 1) Circulating concentrations of IgA and IgG in P1 and P3 dams; 2) Concentrations of IgA and IgG during lactation in colostrum and mid- and late-lactation milk; and 3) Circulating concentrations of IgA and IgG in P1 and P3 progeny. Whole blood was collected via jugular venipuncture from each dam 24 hours pre-farrowing and from dam progeny at 0, 8, 15, 20 (weaning), 29, and 37 days post-farrowing. Serum was harvested by centrifugation (20 min at 1,500 × *g*), diluted (1:100,000) and used to quantify concentrations of IgA and IgG via swine-specific enzyme-linked immunosorbent assays (ELISA; Bethyl Labs Inc., Montogomery Tex.). Colostrum (obtained within 12 hours of parturition), mid-lactation (7 days post-farrowing), and late-lactation (20 days post-farrowing) milk was expressed from each functional teat in sterile flasks and frozen (-20°C) for subsequent analyses. For mid- and late-lactation milk collection, oxytocin

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(40 USP i.m.) was administered to facilitate milk collection. Colostrum and milk samples were diluted (1:50,000) and quantified by ELISA as described above. Results reported for each ELISA included values adjusted according to the dilution factors used for each respective sample.

Statistical analyses

The MIXED procedure of SAS was used to analyze the progeny serum and lactation data as completely random designs with repeated measures over time on each experimental unit. The model included terms for the fixed effects of parity and time and their interaction. Comparisons between parity and time were made only when a significant ($P < 0.05$ unless noted otherwise) F-test for the main effect or interaction was detected using the least significant difference procedure. All means presented are least squares means.

Results and Discussion

The concentration of IgA and IgG in serum obtained from P1 and P3 females 24 hours prior to parturition are depicted in Figure 1. The values obtained for both IgA and IgG are within normal ranges (0.5 to 5.0 and 17.0 to 29.0 mg/mL for IgA and IgG, respectively). However, P3 females had greater concentrations of both IgA and IgG compared to P1 females ($P < 0.01$ and $P < 0.004$, respectively for IgA and IgG). One explanation for this phenomena may be that P1 gilts have greater levels of stress near the time of parturition. It has been documented that gilts have a greater stress load (evidenced by increased concentrations of cortisol) during parturition and it is known that cortisol is immunosuppressive and may act to dampen the immune response (and possibly decrease the production of immunoglobulins during and shortly after parturition).

Even though clear differences exist in circulating concentrations of immunoglobulins between P1 and P3 females at the time of parturition, this trend did not continue when IgA and IgG concentrations were evaluated in colostrum and milk samples obtained from the same females (Figure 2). All immunoglobulin concentrations for colostrum (9.5 to 10.0 and 30.0 to 70.0 mg/mL for IgA and IgG, respectively) and milk (3.0 to 7.0 and 1.0 to 3.0 mg/mL for IgA and IgG, respectively) were within normal ranges. As expected, IgA and IgG concentrations observed in colostrum samples obtained within 12 hours of parturition were greater ($P < 0.0002$) than IgA and IgG concentrations observed in milk samples

Table 1. Comparison of Parity 1 (P1) and Parity 2 (P2) progeny in commercial nursery and finishing barns.

	System 1[a]		System 2[b]	
Parameter	P1 Progeny	P2 Progeny	P1 Progeny	P2 Progeny
Nursery				
Weaning wt, lb	12.1	13.0	11.7	12.6
ADG, lb	0.92	0.95	0.91	0.96
Mortality, %	3.2	2.6	3.2	2.6
Finishing				
ADG, lb	1.99	2.01	1.62	1.69
Mortality, %	4.8	4.8	4.3	3.0

[a]Averages calculated from 242,406 and 677,661 P1 and P2 progeny, respectively.
[b]Total number of progeny were not included.

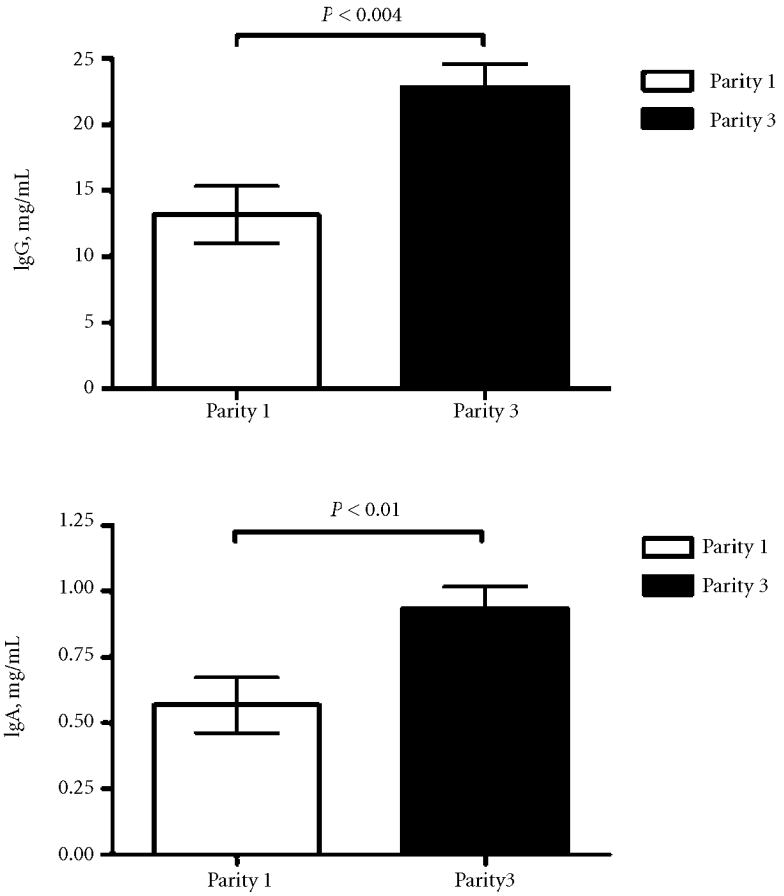

Figure 1. Circulating concentrations of IgG (top panel) and IgA (bottom panel) in gilts (Parity1) and sows (Parity 3). Immunoglobulin concentrations were evaluated in serum obtained within 24 hours pre-farrowing. Each bar represents the least squares mean (± SEM) of 5 observations.

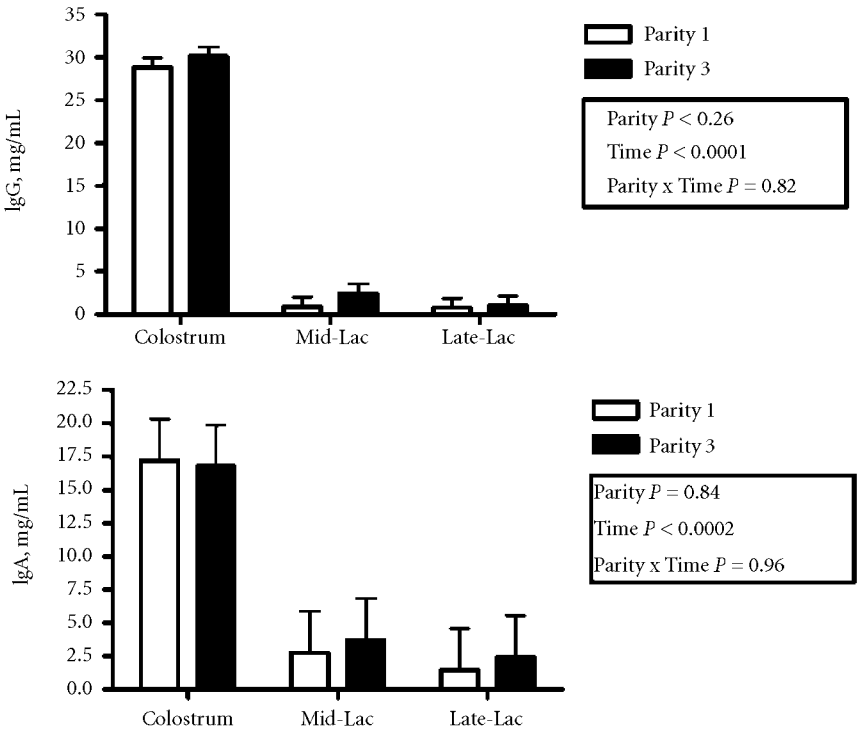

Figure 2. The concentration of IgG (top panel) and IgA (bottom panel) in colostrum and milk (mid- and late-lactation) obtained from gilts (Parity1) and sows (Parity 3) following parturition. Each bar represents the least squares mean (± SEM) of 5 observations.

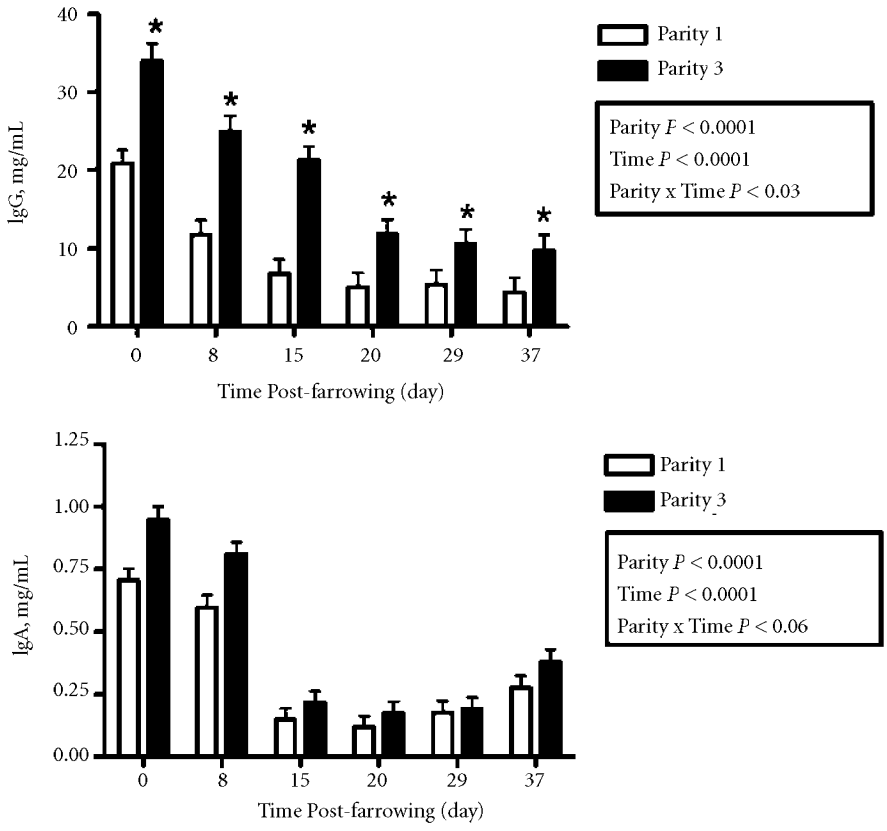

Figure 3. Circulating concentrations of IgG (top panel) and IgA (bottom panel) in serum obtained from the progeny of gilts (Parity1) and sows (Parity 3). Immunoglobulin concentrations were evaluated in serum obtained at 0, 8, 15, 20, 29 and 37 days post-farrowing. Each bar represents the least squares mean (± SEM) of 20 observations. Within a timepoint, (*) denote differences between parities ($P < 0.05$).

obtained at mid- or late-lactation. Although differences exist in immunoglobulin concentrations in the serum of these same females, it was somewhat surprising that no differences in colostrum or milk immunoglobulin concentrations were observed during lactation.

Figure 3 depicts circulating IgA and IgG concentrations in P1 and P3 progeny at several timepoints following parturition. A parity × time interaction was observed for IgG ($P < 0.03$) and there was a trend for a parity × time interaction for IgA ($P = 0.06$). The progeny of P3 females had greater ($P < 0.05$) concentrations of IgG compared to the progeny of P1 females at every timepoint evaluated and, although not statistically significant, a similar numerical trend was observed for IgA. Progeny immunoglobulin concentrations from birth to about 2 weeks of age are almost solely attributed to passive transfer from the dam.

In the current experiment, immunoglobulin concentrations were evaluated to begin to assess the effects of dam parity on progeny health status. The passive transfer of immunity via immunoglobulins is of utmost importance in young pigs because there is no transplacental transfer of immunoglobulins in utero. Therefore, neonatal pigs rely on passive transfer of immunoglobulins via colostrums and milk until they can synthesize their own immunoglobulins beginning from 2 to 5 weeks of age. Clearly, it would be advantageous for P3 progeny to have greater concentrations of circulating immunoglobulins (as observed in the current study, Figure 3) compared to lower concentrations observed in P1 progeny. This advantage may improve the overall health status of the animal by increasing immune protection against environmental antigens.

The health status of an organism is related to complex physiological, biological and environmental interactions. According to our observations, the parity differences in circulating immunoglobulins between P1 and P3 progeny may not be attributed to

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a similar trend in immunoglobulin concentrations in colostrum/milk via passive transfer. It is unclear why P3 progeny have greater concentrations of circulating immunoglobulins. One explanation is that P3 sows may simply provide a greater volume of colostrum/milk to their offspring carrying a greater volume of immunoglobulins. Another explanation is that P3 progeny may have greater expression of immunoglobulin receptors on intestinal epithelial cells allowing greater immunoglobulin absorption.

Conclusions

This preliminary experiment suggests that dam parity may influence progeny health status. Additional research in this area will help elucidate the effects of dam parity on progeny health status and may also provide insight towards developing new strategies to improve production efficiency.

[1]Thomas E. Burkey is an assistant professor, Phillip S. Miller and Rodger K. Johnson are professors, Duane Reese is an extension swine specialist, and Roman Moreno is a graduate student and research technologist in the Animal Science Department. The authors would also like to thank Matthew W. Anderson, Daryl J. Barnhill, Kelsey A. Rhynalds and Brenda B. Williams. References available upon request from tburkey2@unl.edu