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Effect of Dam Parity on Litter Performance and Passive Immunity

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Effect of Dam Parity on Litter Performance and Passive Immunity

Litter performance and passive immunity may be affected by dam parity.

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Summary

Preliminary experiments (reported in the 2008 Nebraska Swine Report) suggest that progeny health status may be affected by dam parity. However, the preliminary experiments only included a small population of sows and their progeny. Therefore, the objective of the current experiment was to evaluate litter performance and the production and passive transfer of immunoglobulins (Ig) in dams (P1 vs. P4) and their progeny. Litter birth weight tended ($P < 0.10$) to be greater for P4 progeny compared to P1 progeny. No effects of dam parity were observed on circulating Ig in dams during gestation or at parturition. However, concentrations of IgA tended ($P < 0.09$) to be greater for P4 sows compared to P1 gilts in samples of colostrum and milk and serum IgG concentrations were greater ($P < 0.02$) for P4 progeny compared to P1 progeny across all preweaning samples. These results suggest that litter performance and health status may be affected by dam parity.

Introduction

Anecdotal observations suggest that progeny of gilts (P1) have reduced health status and subsequent performance compared to progeny of sows ($\geq$ P2). Unpublished reports demonstrate that P1 progeny have reduced weaning weights, decreased nursery and finishing ADG and greater mortality than P2 progeny. In addition, work by Mahan et al. (1998) showed that mature sows ($\geq$ P2) had a greater litter gain per day than P1 gilts. In all of these reports, it is generally accepted that differences observed between parities result from reduced health status in P1 progeny. Although it remains unclear, several findings may help explain why health status and performance of progeny seems to vary between parities. It is possible that progeny health status is affected by factors including (but not limited to) animal stress, passive immunity, and susceptibility to pathogens. With respect to passive immunity, maternal colostrum provides Ig that are absorbed within the first 24 hours after birth. The concentration of IgG in colostrum ingested by the suckling piglet affects the concentration of circulating IgG in piglet serum. When passive immunity is low or fails, the piglet's health status decreases and may affect survivability. Therefore, receiving adequate colostrum in the first 24 hours after birth is extremely important.

Preliminary data generated at the University of Nebraska *(2008 Nebraska Swine Report)* resulted in several interesting observations. First, at parturition, circulating concentrations of immunoglobulins (IgA and IgG) were greater in P3 dams compared to P1 dams. Second, with respect to immunoglobulin concentrations during lactation, no parity differences were observed between P1 and P3 dams. Third, circulating concentrations of immunoglobulins (IgA and IgG) were greater in P3 progeny compared to P1 progeny in samples obtained at weekly intervals from birth to 37 days of age. These three observations suggest that passive immunity may be affected by dam parity. It is important to emphasize that the aforementioned observations are a result of a preliminary study conducted with a limited number of observations. Therefore, the objective of the current experiment was to evaluate, on a larger scale, litter performance and production and passive transfer of IgG and IgA between P1 and P4 dams and 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. Dams (Large White × Landrace) utilized in the current study included first parity gilts (P1; $n = 19$) and fourth parity sows (P4; $n = 24$) that all farrowed over a 22-day period beginning December 17, 2007, and ending January 7, 2008. Dams were co-mingled and housed in stalls during gestation and moved to farrowing crates approximately five days prior to their expected farrowing date. Dam and litter performance was recorded for both P1 and P4 females. The dam and litter performance parameters recorded included: No. of pigs/litter (total born, born live, stillbirths, mummified fetuses, pigs weaned, and preweaning mortality), litter weight at birth (LBW), and litter weight at weaning (LWW). All piglets from each litter were weighed on day 0, 7, 14, and at weaning (day 19).

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Laboratory Analysis

Blood samples were collected from all sows via jugular venipuncture at two time points during gestation (day 90 and 114) and at a final time point immediately following parturition (day 0). During lactation, samples were obtained at day 0 (colostrum), 7 (mid lactation), and 14 (late lactation) from each functional teat in sterile flasks and frozen (-20°C) for subsequent analyses. For mid- and late-lactation milk collection, oxytocin was administered to facilitate milk collection. Colostrum and milk samples were diluted (1:50,000) and concentrations of IgA and IgG were quantified as described below. Blood samples were collected from six piglets from each litter on day 1, 7, and 14. Serum was harvested by centrifugation (20 minutes at 1,500 × *g*) and frozen for subsequent analyses. Concentrations of immunoglobulins (IgA and IgG) in serum, colostrum, and milk were quantified via swine-specific enzyme-linked immunosorbent assays (ELISA; Bethyl Labs Inc., Montogomery, Tex.).

Statistical Analysis

The MIXED procedure of SAS was used to analyze the progeny serum and lactation data as a completely random design 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. Litter performance data was analyzed using the MIXED procedure of SAS as a completely randomized design.

Table 1. Treatment effects of sow parity on litter and pig measurements.

	Parity			
Item	1	4	SEM[a]	*P*-value
No. of sows	19	24		
Pigs, No./litter				
Total born	12.79	12.79	1.2	0.99
Born live	12.00	11.50	1.1	0.66
Stillbirths	0.63	1.13	0.3	0.12
Mummified fetuses	0.16	0.21	0.2	0.68
Mortality (preweaning)	2.68	1.83	0.8	0.26
Weaned	10.16	10.13	0.6	0.96
Litter wt, lb				
Birth (day 0)	15.73	17.89	1.3	0.10
Weaning (day 19)	55.14	58.07	4.8	0.55

[a]SEM = Standard error of the mean

Results and Discussion

Dam and litter performance are presented in Table 1. There was no effect of parity on number (pigs/litter) of total born, born live, stillbirths, mummified fetuses, deaths, or on LWW. However, P4 dams tended to have greater LBW compared to P1 dams ($P = 0.10$) and P4 dams had a numerical decrease in preweaning mortality (number of deaths) and a numerical increase in LWW. Progeny BW is represented in Figure 1. There was no significant parity × time interaction for piglet BW. However, across all time points P4 progeny had greater ($P < 0.0005$) BW than P1 progeny. We expected to have greater differences in dam and litter performance; however, according to previous research it is possible that the greatest differences in performance occur between P1 and P2 or P3 dams.

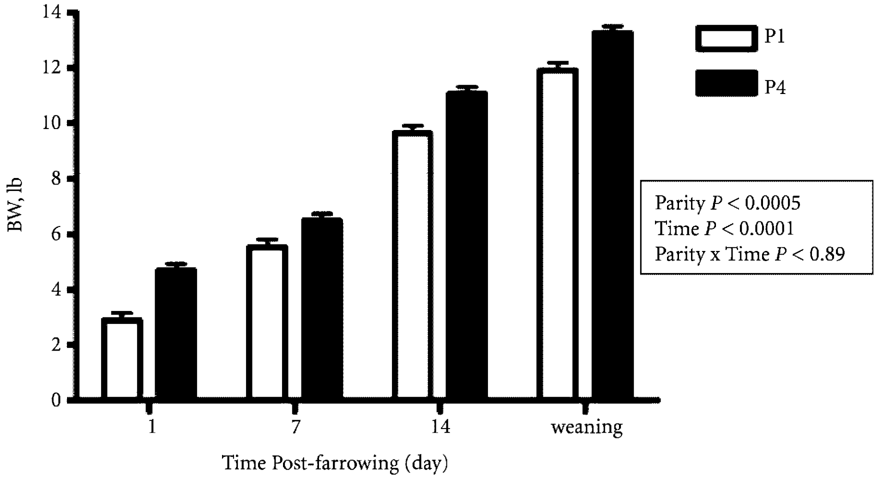

Figure 1. Average body weight (BW) of piglets of gilts (P1) and sows (P4) taken on day 0, 7, and 14 following parturition. Each bar represents the least squares mean (± SEM) of the progeny of 19 and 24 observations for P1 and P4 dams, respectively.

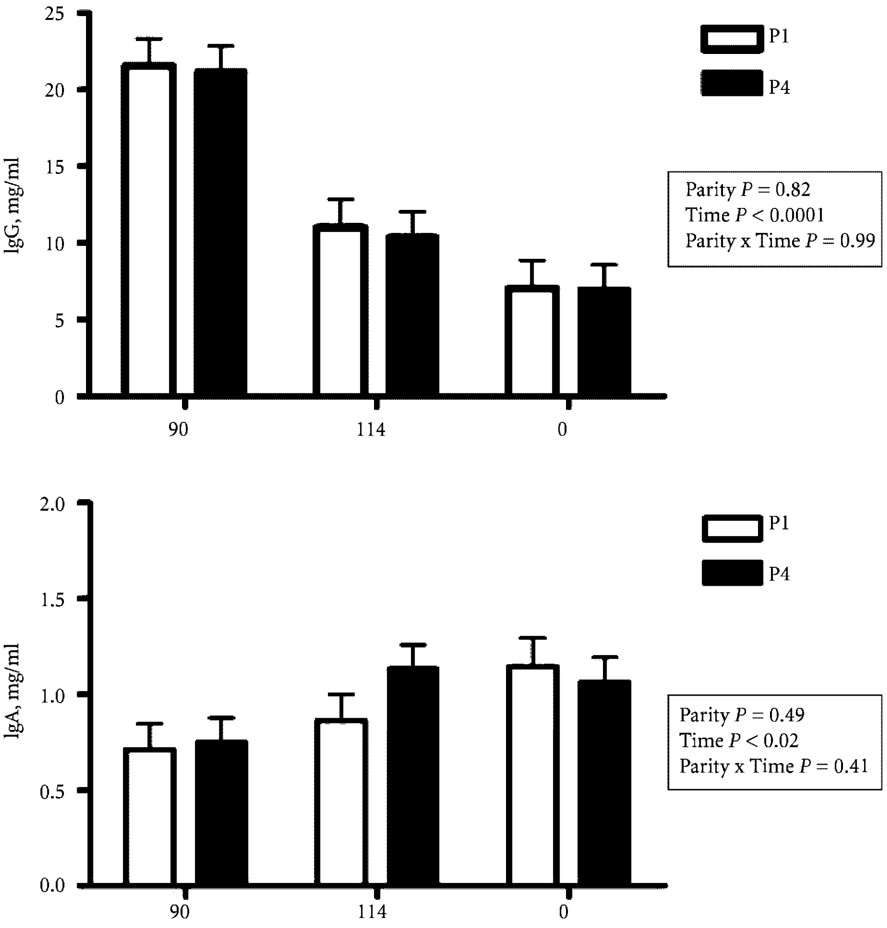

Figure 2. **Circulating concentrations of IgG (top panel) and IgA (bottom panel) in gilts (P1) and sows (P4). Immunoglobulin concentrations were evaluated in serum obtained at day 90 and 144 of gestation and immediately following parturition (day 0). Each bar represents the least squares mean (± SEM) of 19 and 24 observations for P1 and P4 dams, respectively.**

Figure 2 depicts circulating concentrations of IgG and IgA in P1 and P4 dams during gestation (day 90 and 114) and following parturition (day 0). A significant parity × time interaction was not observed and there were no main effects of parity on circulating Ig. However, consistent with previous reports, there was a significant effect of time when means were averaged across both parities ($P < 0.05$). While circulating IgA increases as the dams approached farrowing, circulating IgG concentrations decreased over time with the lowest concentrations observed at farrowing (day 0). This observation may contribute to the higher levels of IgA in mid- and late-lactation milk when compared to IgG.

Concentrations of IgG and IgA in samples of colostrum and milk obtained during lactation are represented in Figure 3. There was no significant parity × time interaction or main effect of parity on IgG concentrations during lactation. However, IgG concentrations averaged across both parities were greater for colostrum when compared to mid- and late-lactation samples ($P < 0.05$). With respect to IgA, no parity × time interaction was observed. However, there was a tendency for IgA concentrations to be greater in P4 dams compared to P1 dams when means are averaged across all time points ($P = 0.09$). Similar to IgG, the greatest concentrations of IgA were observed during early lactation (colostrum) ($P < 0.05$).

No significant parity × time interactions were observed for either IgG or IgA when circulating Ig concentrations were measured in serum from P1 and P4 progeny (Figure 4). Piglets derived from P4 dams had greater circulating IgG concentration when compared to P1 progeny when means are averaged across all time points ($P < 0.02$). There was no main effect of parity on circulating IgA concentrations in P1 and P4 progeny; however, P1 progeny had numerically decreased IgA concentrations compared to P4 progeny at day 1 and 7.

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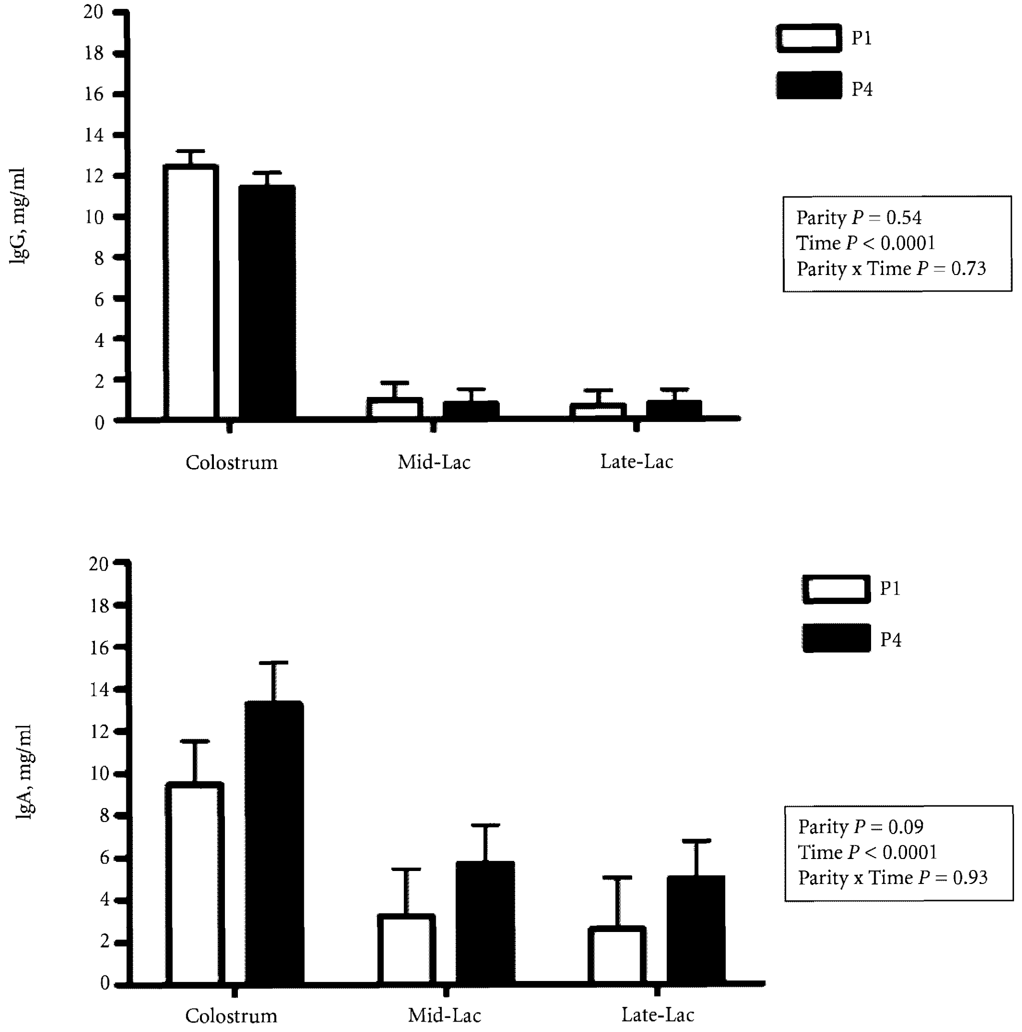

Figure 3. Concentrations of IgG (top panel) and IgA (bottom panel) in colostrum, mid lactation (7 days following parturition; mid-lac), and late-laction (14 days following parturition; Late-Lac) milk samples obtained from gilts (P1) and sows (P4). Each bar represents the least squares mean (± SEM) of 19 and 24 observations for P1 and P4 dams, respectively.

As expected, a main effect of time was observed for both IgG and IgA with circulating Ig concentrations decreasing over time when means are averaged across both parities ($P < 0.001$).

Conclusion

The level of passive immunity in a given population of piglets varies according to the amount of colostrum they ingest. In addition, the level of passive immunity acquired may directly affect the development of active immunity and indirectly affect the health and performance of the piglet. The results described in this report suggest that mature dams (P4) may provide their progeny with advantages in provision of passive immunity. However, further research is needed to determine if these observations are consistent throughout the sow's reproductive lifetime.

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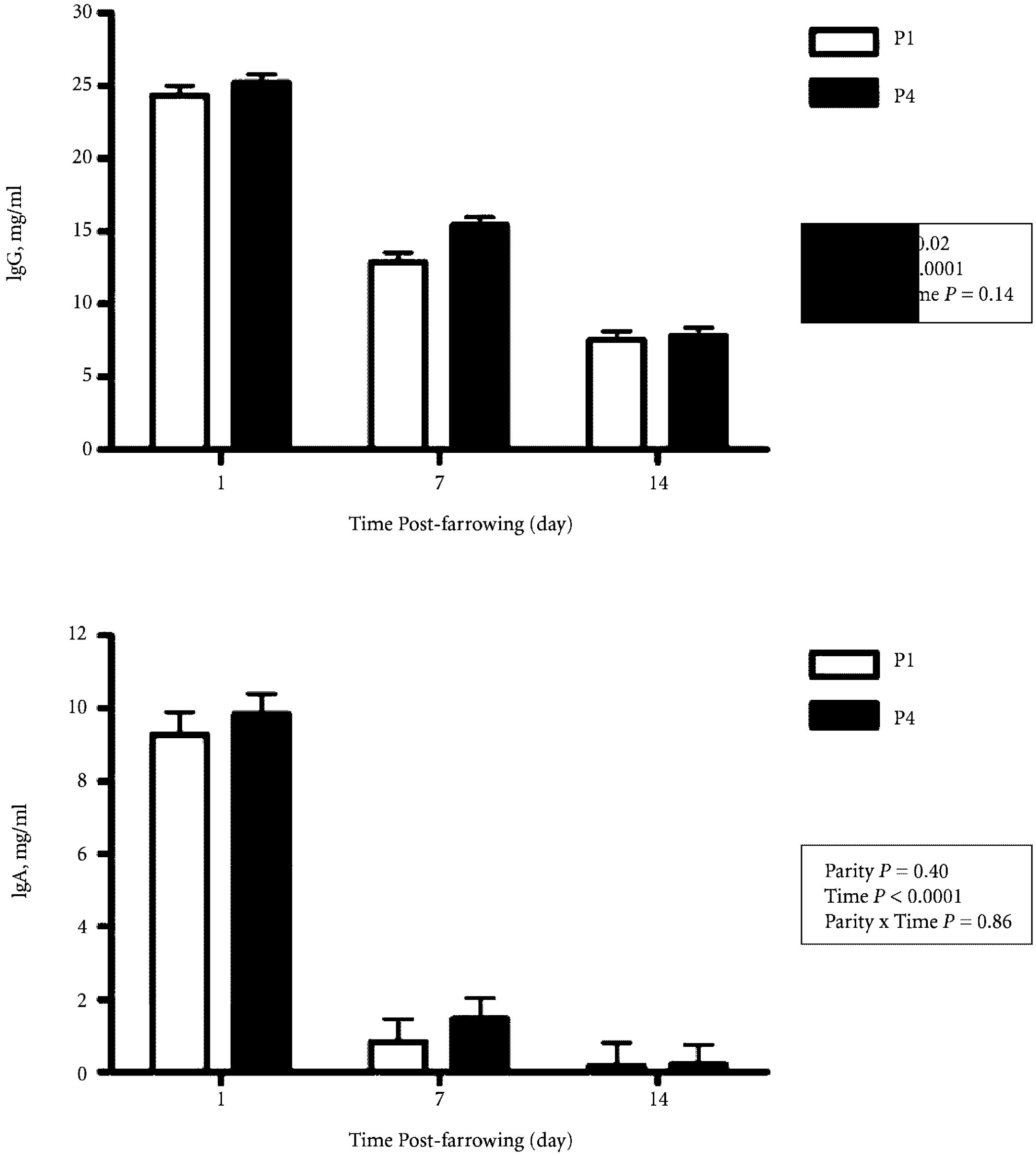

Figure 4. **Circulationg concentrations of IgG (top panel) and IgA (bottom panel) in serum obtained from the progeny of gilts (P1) and sows (P4). Immunoglobulin concentrations were evaluated in serum obtained at 1, 7, and 14 days post-farrowing. Each bar represents the least squares mean (± SEM) of the progeny of 19 and 24 observations for P1 and P4 dams, respectively.**