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Utilization of Enrichment Blocks in Group-Housed Sows Under Commercial Conditions: Effects on Aggressive Interactions and Sow and Litter Performance

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Summary

A total of 960 mixed-parity sows and gilts (1050, PIC) were used to evaluate the effects of environmental enrichment during the last two weeks of gestation on sow performance and behavior. Gestating sows were randomly assigned to control pens with no enrichment (n = 9 pens; 53.2 ± 2.2 sows/pen) or pens containing three molasses and beet pulp-based enrichment blocks (n = 9 pens; 53.4 ± 1.1 sows/pen). Sows were weighed the day prior to the start of treatment and again upon entry into farrowing. Sow body lesions and vulva lesions were recorded the day before exposure to treatment and then again on d 3 and 5 after exposure and finally upon entry to farrowing. Four sows per pen were selected and had tear stain scores recorded the day before exposure to treatment and upon entry to farrowing. Sows were video recorded continuously, and video was analyzed on d 3 and 5 in six 2-h time frames (0100 to 0300, 0500 to 0700, 0900 to 1100, 1300 to 1500, 1700 to 1900, and 2100 to 2300). Aggressive bouts were defined as 1) sows knocking or pushing pen mates with their head; 2) sows mounting pen mates; or 3) sows forcefully biting ear, face, body, or vulva of pen mates. The location of aggressive bouts was recorded and categorized as either occurring at the feeder (feeder bout) or elsewhere in the pen (non-feeder bout). One sow per pen was selected based on average body condition and parity of the pen for determination of salivary cortisol levels on d 3 and 5. Those sows were followed through farrowing with one male and one female piglet of the average litter BW being analyzed for plasma and hair cortisol concentrations. Piglets were restrained on their backs for 3 min prior to blood collection to induce a stress response, and hair samples were taken from the rump and dorsal area immediately after. Sows assigned to the enrichment blocks tended to have

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increased (P = 0.051) ADFI; however, this did not translate to a difference in ADG during late gestation. No differences were observed in total born, live born, stillborn or number weaned. The use of enrichment blocks led to a reduction (P = 0.029) in total aggressive bouts within pens, driven by the tendencies for reduction (P ≤ 0.096) in both feeder and non-feeder aggressive bouts. Regardless of treatment, total aggressive interactions were greater (P < 0.01) on d 3 than on d 5 and declined (P < 0.01) as time of day progressed. No differences in sow salivary cortisol concentrations, piglet hair cortisol concentrations, or piglet plasma cortisol concentrations were observed. In conclusion, the provision of environmental enrichment during late gestation modestly reduced aggressive interactions but did not affect sow and litter performance or physiological stress indicators in a group-housed environment under commercial production conditions.

Introduction

Implementation of gestation group housing has been on the rise in the swine industry with efforts to increase behavioral freedoms of sows. Although sows are less restricted, this strategy led to an increased prevalence of aggressive behaviors, adding a new challenge for production systems. Research has been conducted surrounding gestation aggression[4],[5],[6]; however, most efforts have focused on strategies aimed to reduce aggression immediately post-mixing when sows are still developing their social hierarchies5. Although post-mixing aggression is still a concern, field reports have also suggested an increase in late gestation aggression. This can be viewed through an increase in vulva and body lesions as sows approach farrowing. This increase in aggression just prior to farrowing is not only a welfare concern but may also lead to potential difficulties during parturition.

Providing group-housed sows with environmental enrichment blocks could potentially be a practical way to reduce aggressive behaviors in late gestation. Previous research found that when mixing gestating sows, suspended molasses enrichment blocks led to a reduction in body lesion scores and increased lying behavior, potentially due to a decrease in aggressive behavior[7],[8]. However, implementation of this strategy needs additional research in a commercial setting, specifically during the late gestation period.

[4] Stevens, B., G. M. Karlen, R. Morrison, H. W. Gonyou, K. L. Butler, K. J. Kerswell, and P. H. Hemsworth. 2015. Effects of stage of gestation at mixing on aggression, injuries and stress in sows. Appl. Anim. Behav. Sci. 165:40-46. doi:10.1016/j.applanim.2015.02.002.

[5] Greenwood, E. C., K. J. Plush, W. H. E. J. van Wettere, and P. E. Hughes. 2016. Group and individual sow behavior is altered in early gestation by space allowance in the days immediately following grouping. J. Anim. Sci. 94(1):385-393. doi:10.2527/jas.2015-9427.

[6] Verdon, M., R. S. Morrison, M. Rice, and P. H. Hemsworth. 2016. Individual variation in sow aggressive behavior and its relationship with sow welfare. J. Anim. Sci. 94(3):1203-1214. doi:10.2527/jas.2015-0006.

[7] Marchant, J. N., C. Rikard-Bell, and E. Jongman. 2023. A suspended molasses block improves post-mixing welfare of gestating sows. J. Anim. Sci. 101:3-4. doi:10.1093/jas/skad281.004. (Abstr.)

[8] Muller, T. L., R. J. E. Hewitt, and R. J. van Barneveld. 2015. Nutritional management strategies to reduce aggression at mixing of unfamiliar sows. Co-operative Research Centre for High Integrity Australian Pork. https://porkcrc.com.au/wp-content/uploads/2014/12/1C-115-Final-Report.pdf

Therefore, the objective of this study was to evaluate the effects of environmental enrichment through the use of suspended molasses and beet pulp-based blocks in late gestation on sow performance, pen behavior, and physiological stress indicators of group-housed sows under commercial conditions.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The experiment was conducted at a commercial sow farm in Carthage, IL. Sows were housed in 18 pens, with each pen (36.66 × 27.66 ft) equipped with three computerized gestation feeders (Gestal; Jyga Technologies, St-Lambert-de-Lauzon, Quebec, Canada) and four cup drinkers to provide ad libitum access to water. Sows were fed a common diet and allocation of feed each day began at 0100 in the computerized feed system.

Animals and diets

A total of 960 mixed-parity sows and gilts (1050, PIC) were used. Sows were housed in 18 pens containing approximately 53 sows/pen. Pens of sows were blocked in groups, based on earliest breed dates of sows within pen to account for date of pen loading and then allotted to one of two treatments with nine replicate pens per treatment. Pens containing sows with different breed dates and treatments started when sows reached 103.0 ± 1.1 d of gestation. Treatments consisted of 1) control pens with no enrichment or 2) pens containing three molasses and beet pulp-based enrichment blocks (Allbite, Alltech, Nicholasville, KY) suspended from the ceiling. Two molasses blocks were suspended along the center width of the pen, approximately 6 ft in from the side panels to avoid interfering with access to the water. A third molasses block was suspended between the other two at approximately half the length of the pen; however, its location was shifted back approximately 2 ft compared with the other two blocks to avoid interfering with feeder access. The bottom of each molasses block was positioned approximately 3 ft above the floor, with the goal of placing the blocks just below the shoulder height of the sows. Most molasses blocks remained intact for the duration of the experimental period; however, if a block was damaged or torn down, it was replaced. Sows were weighed the day before the start of treatment and again upon entering farrowing. Litter counts were taken upon birth and then again at weaning to determine litter performance data.

Within each pen, four sows were selected based on average parity of the pen and average body condition to serve as the focal sows of the pen. All four of these sows had tear stains scored when recording initial BW and again when entering farrowing. Tear stains were recorded on a 0 to 5 scale (Table 1). At initial weight, d 3, and d 5 after exposure to treatment and then upon entry to farrowing, all sows within pen had body and vulva lesion scores recorded. Sow body lesion scores were recorded on a scale of 0 to 3 with vulva scoring on a scale from 0 to 2.

Video analysis

Using video cameras (PAR-ALLTXIRA28WL: Fixed lens, IP67 Weatherproof, 2 Megapixel Turret, 2.8-mm lens with 30 fps (60 Hz); Innovative Video Technology, Hauppauge, NY) connected to a network video recording system (PN3A-64FNH: NTSC/PAL, 64 Ch TVI NVR, AC110-240V; Innovative Video Technology, Hauppauge, NY), sows were video recorded continuously. Recorded video was analyzed on d 3 and 5 in six 2-h time frames (0100 to 0300, 0500 to 0700, 0900 to 1100, 1300

to 1500, 1700 to 1900, and 2100 to 2300). Aggressive bouts were defined as 1) sows knocking or pushing pen mates with their head; 2) sows mounting pen mates; or 3) sows forcefully biting ear, face, body, or vulva of pen mates. Aggressive bouts were categorized as either "feeder aggressive bouts" or "non-feeder aggressive bouts." Feeder aggressive bouts were defined as bouts that occurred while at least one sow was standing behind the feed stations with her nose in the station. All other aggressive bouts were labeled "non-feeder" bouts. The combination of both feeder and non-feeder aggressive bouts was labeled as "total" aggressive bouts.

Biological tissue and fluid analyses

Within each pen, one sow was chosen to have salivary cortisol levels analyzed. Saliva was collected between 0700 and 0900 on d 3 and 5 after exposure to treatment. Saliva samples were collected using a Super-SAL Universal Saliva Collection Kit (Oasis Diagnostics, Vancouver, WA). Sows voluntarily chewed on the collection device until fully saturated. Samples were compressed into 2-mL containers and stored at −4.0°F on the farm until samples were moved to the University of Missouri and stored at −112.0°F until analysis. Samples were analyzed using a commercially available ELISA kit for salivary cortisol (IBL Cortisol Free in Saliva ELISA; IBL America, Minneapolis, MN) following the manufacturer's instructions.

Sows selected for saliva collection were also tracked through farrowing for collection of piglet blood and hair cortisol. The day before weaning, all piglets within the litter were weighed and the male and female closest to the average weight of the litter were chosen for collection. Piglets were restrained on their back for 3 min to induce a stress response, and then blood samples were taken in tubes containing an anticoagulant (Greiner Bio-One North America Inc., Monroe, NC). Blood samples were centrifuged within 4 h of sample collection with plasma samples being stored at −112.0°F until further analysis. Cortisol analysis was performed on all plasma samples using a Cortisol ELISA Kit (IBL America, Minneapolis, MN).

At the same time as blood collection, hair samples were collected for additional cortisol analysis. A hair sample was collected from the rump and dorsal area of the piglets and processed as previously described by Byrd et al.[9].

Statistical analysis

Sow performance data were analyzed using the lmer function from the lme4 package in RStudio (Version 4.0.2, R Core Team, Vienna, Austria) with pen serving as the experimental unit and sow as the observational unit in a randomized complete block design. Pens were grouped into blocks to account for pen loading date. Treatment was used as a fixed effect in the model with pen and block serving as random effects. Sow parity and days exposed to treatment were included as covariates in the model. Count data, including subsequent litter characteristics (total born, born alive, stillborn, mummies, and weaned) were analyzed using a negative binomial distribution using a log link function.

[9] Byrd, M. H., L. F. Brito, J. Musa, S. Diggs, L. K. Senn, H. Wen, P. H. F. Freitas, J. L. Byrd, F. Tiezzi, C. Maltecca, Y. Huang, A. P. Schinckel, and J. S. Johnson. 2025. Characterizing the effects of gestational heat stress on reproductive efficiency and thermoregulation in replacement gilts divergently selected for thermotolerance in the F1 generation. J. Anim. Sci. 103:skaf353. doi:10.1093/jas/skaf353.

Sow aggressive bouts, vulva lesions, body lesions, tear stains, sow salivary cortisol, piglet hair cortisol, and plasma cortisol levels were analyzed using the GLIMMIX procedure of SAS OnDemand for Academics (SAS Institute, Inc., Cary, NC). Aggressive bouts were reported as the number of interactions per hour of video viewed. The model for aggressive bouts included treatment, day, time, and their interactions as fixed effects with block as a random effect. Treatment, day, and their interactions were considered fixed effects for sow vulva lesion, body lesion, and tear stain scores with initial scores used as a covariate. Sow salivary cortisol levels were log-transformed and then back-transformed to give estimated means. The model included treatment, day, and their interactions as fixed effects with block as a random effect. Piglet plasma values were log-transformed, while hair cortisol was square root transformed, and both were back-transformed to give estimated means. The model for piglet plasma and hair cortisol levels included treatment as a fixed effect with block and number born alive as random effects. All results were considered significant with $P \leq 0.05$ and marginally significant with $P \leq 0.10$.

Results and Discussion

There were no differences in sow BW between treatments (Table 2). Although sows provided enrichment blocks tended to have greater ($P = 0.051$) ADFI, ADG was not affected. No differences were observed in total born, born alive, mummies, stillborn, and number weaned.

There were no observed differences in body or vulva lesion scores between treatments. Regardless of treatment, vulva lesion scores increased ($P < 0.001$) as sows approached farrowing (Figure 1). In contrast, body lesion scores decreased ($P < 0.001$) over the same period (Figure 2).

Providing enrichment blocks did not affect sow salivary cortisol or piglet plasma and hair cortisol concentrations. The use of enrichment blocks led to a reduction ($P = 0.029$) in total aggressive bouts within pens, driven by the tendencies for reductions ($P \leq 0.096$) in both feeder and non-feeder aggressive bouts. Regardless of treatment, total aggressive interactions were greater ($P < 0.05$) on d 3 than on d 5 and declined ($P < 0.05$) as time of day progressed.

In conclusion, the provision of environmental enrichment during late gestation modestly reduced aggressive interactions but did not affect sow and litter performance or physiological stress indicators in a group-housed environment under commercial production conditions.

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Table 1. Scoring scale used to determine body lesions, vulva lesions, and tear staining

Body lesion scoring	
0	No injuries.
1	≤ 4 superficial injuries.
2	5 to 10 superficial injuries and/or less than 2 deep wounds.
3	≥ 11 superficial injuries and/or more than 3 deep wounds.
Vulva scoring	
0	No damage to the vulva.
1	Recent damage, including fresh or scabbed bite wounds but not including old scarring. Vulva lesion > 3 cm length or 1 cm diameter.
2	Deep tissue injury.
Tear stain scoring	
0	No signs of staining.
1	Staining is barely detectable and area stained does not extend below eyelid.
2	Staining is obvious and area stained is approximately < 50% of total eye area.
3	Staining is obvious and area stained is approximately 50 to 100% of total eye area.
4	Staining is severe, area stained is approximately ≥ 100% of total eye area, and area stained does not extend below the mouth line.
5	Staining is severe, area stained is > 100% of total eye area, and area stained extends below the mouth line.

Table 2. Effects of environmental enrichment during late gestation on sow performance, litter characteristics, cortisol responses, and aggression in commercially group-housed sows

Item	Control	Enrichment	SEM	*P* =
Sow performance[1]				
Initial BW, lb	579.3	580.9	4.04	0.708
Farrow entry BW, lb	600.5	603.0	3.82	0.501
ADG, lb	2.04	2.19	0.073	0.186
ADFI, lb	4.87	4.98	0.047	0.051
Litter characteristics				
Total born, n	17.47	17.53	0.199	0.842
Born alive, n	15.08	15.26	0.193	0.497
Stillborn, n	1.92	1.72	0.144	0.300
Mummies, n	0.44	0.47	0.047	0.684
Weaned, n	12.10	12.49	0.172	0.102
Cortisol[2]				
Sow salivary, ng/mL	7.9	7.1	1.34	0.586
Piglet plasma, ng/mL	49.4	40.3	5.19	0.109
Piglet hair, pg/mg	7.1	7.3	0.98	0.879
Aggression, interactions/h				
Non-feeder bouts	9.4	7.8	0.72	0.053
Feeder bouts	5.2	4.3	2.39	0.096
Total bouts	15.0	12.5	2.49	0.029

[1] A total of 960 mixed-parity sows and gilts (1050, PIC) were used to evaluate the effects of environmental enrichment (Allbite, Alltech, Nicholasville, KY) provided in late gestation. ADG and ADFI were measured from when first sows within pen reached d 104 of gestation, until all sows entered farrowing.

[2] All samples were analyzed for cortisol at the Missouri Stress Physiology Lab, Columbia, MO.

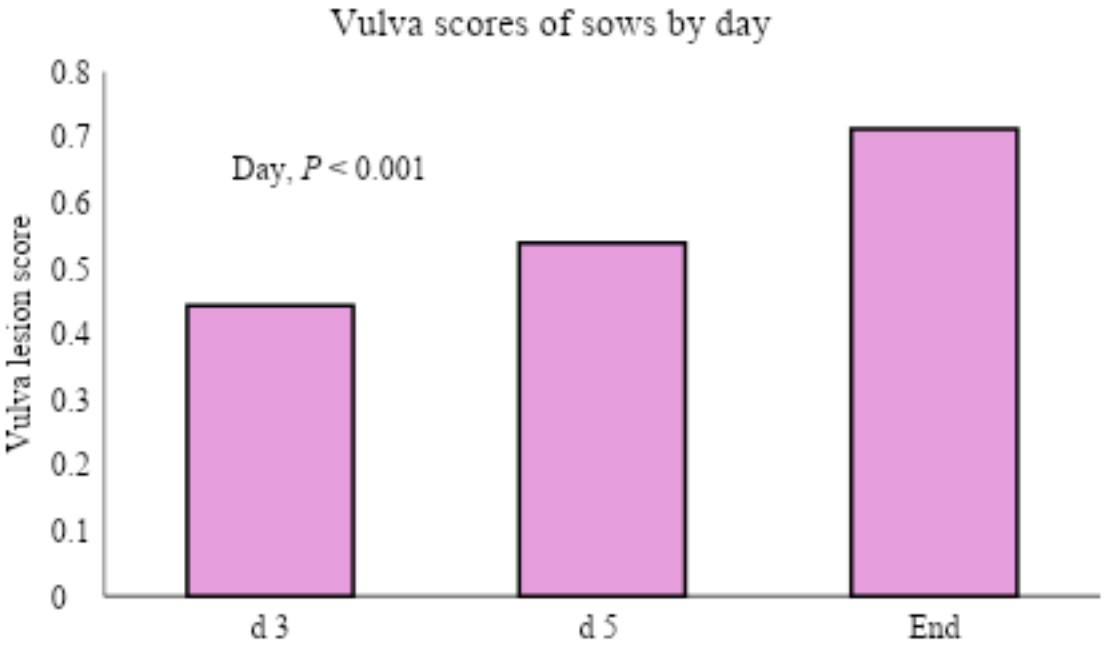


Figure 1. Vulva scores presented on 0 to 2 scale: 0 = No damage to vulva; 1 = Recent damage, including fresh or scabbed bite wounds but not including old scarring, vulva lesion > 3 cm length or 1 cm diameter; and 2 = Deep tissue injury. Scores of sow vulvas were recorded the day before starting treatment (d 0), then on d 3 and 5 after exposure to treatment, and upon entry into farrowing. Treatment × day, P = 0.372; Treatment, P = 0.977.

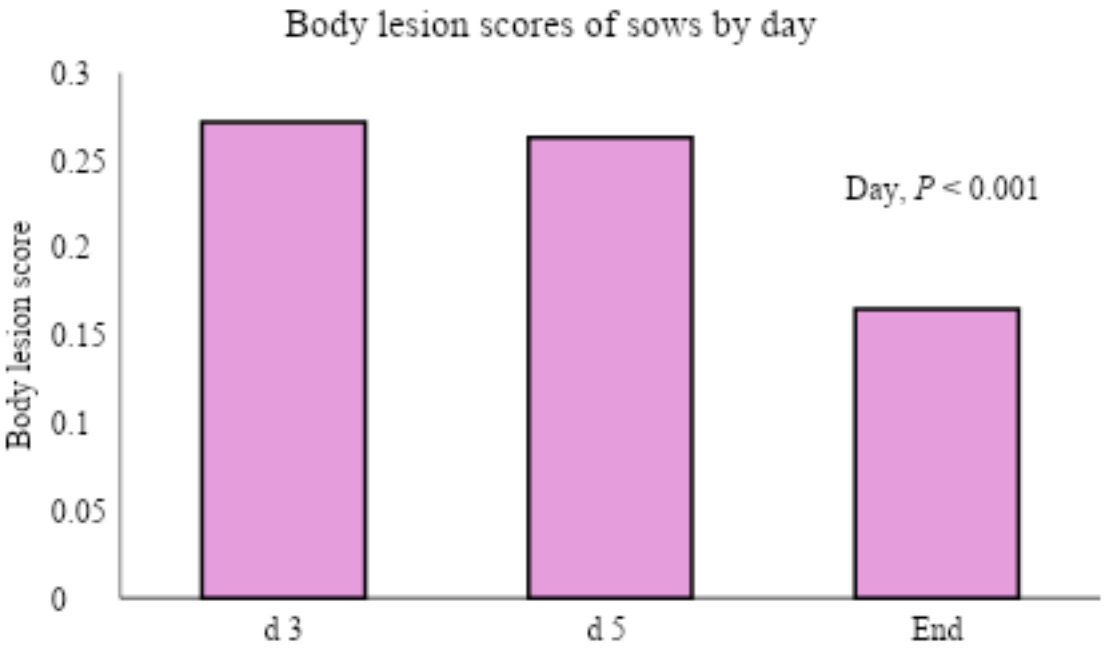


Figure 2. Body lesion scores presented on 0 to 3 scale. 0 = No damage; 1 = ≤ 4 superficial injuries; 2 = 5 to 10 superficial injuries and/or less than 2 deep wounds; 3 = ≥ 11 superficial injuries and/or more than 3 deep wounds. Scores of sow body lesions were recorded the day before starting treatment (d 0), then on d 3 and 5 after exposure to treatment, and upon entry into farrowing. Treatment × day,
P = 0.124; Treatment, P = 0.267.