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Effect of Lysine-Fermentation By-Product on Urine pH and Total Urine Bacteria Count in Lactating Sows[1]

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Summary

A total of 27 mixed parity sows (Line 241; DNA, Columbus, NE) were used in a lactation study to determine the effect of a lysine-fermentation by-product on sow urine pH and total urine bacteria counts. On d 110 of gestation, females were weighed, blocked by BW and parity, and allotted to 1 of 2 dietary treatments. Dietary treatments included a control (corn-soybean meal lactation diet) or the control diet that was acidified by the addition of 1.75% (as-fed basis) of a lysine-fermentation by-product. The dietary electrolyte balance (dEB) was calculated using the following equation (dEB ={[(Na/23) + (K/39.1)] – [(Cl/35.5) + (S/16)]} × 10,000). The calculated dEB was 95.9 and -23.7 mEg/kg for the control and acidified diets, respectively. Sows were fed the lysine-fermentation by-product diet from d 110 of gestation until d 10 of lactation, at which point they were switched to the control diet for the remainder of the lactation period. There was no evidence for difference in urine pH ($P > 0.05$) between dietary treatments at d 110 of gestation; however, at farrowing and d 10 of lactation, there was a reduction ($P = 0.001$) in urine pH in sows fed the lysine-fermentation by-product compared to sows fed the control diet. By weaning (d 19) there was no evidence for differences in urine pH observed among the dietary treatments. There was no evidence for differences ($P > 0.05$) in total bacteria count in urine between sows fed either dietary treatment on d 110 of gestation, farrowing, d 10 of lactation, or weaning. Overall, lowering dEB with the lysine-fermentation by-product resulted in decreased urine pH. Additional research should be conducted with a larger number of sows to determine the impact of lysine-fermentation by-product on indicators of sow farm productivity and profitability.

Introduction

The dietary electrolyte balance (dEB) in swine diets can be altered by including acidifiers. A reduction in pH within the GI tract can decrease the development of bacteria

[1]Appreciation is expressed to Ajinomoto Heartland, Inc. (Chicago, IL) for partial financial support of this experiment.

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and potentially improve pre-weaning mortality.[4] Lowering pH also allows sows to mobilize calcium to be used during muscle contractions in farrowing, thus reducing stillbirths. Additionally, lowering the pH of the urine may also help to reduce urinary tract infections.[5] Most previous research utilizes protected calcium chloride products or inorganic acidifiers to lower urine pH.[3]

This particular by-product from the fermentation of crystalline lysine (Ajinomoto Heartland Inc., Chicago, IL) has a high sulfur content. Because sulfur is an anion, it has the ability to decrease the dEB of the diet. However, this fermentation by-product has never been evaluated in lactating sows. Therefore, the objective of this study was to determine the effect of including the lysine-fermentation by-product in sow diets on urine pH and bacteria concentrations.

Procedures

A total of 27 sows were moved into the farrowing house on d 110 of gestation and allotted by BW and parity to 1 of 2 dietary treatments. Dietary treatments included a control (corn-soybean meal lactation diet) or the control diet that was acidified with the addition of 1.75% (as-fed basis) of lysine-fermentation by-product (Table 1). Corn was replaced by the lysine-fermentation by-product to achieve the treatment diet (Table 2). The dietary electrolyte balance was calculated using the following equation: dEB ={[(Na/23) + (K/39.1)] – [(Cl/35.5) + (S/16)]} × 10,000. The calculated dEB was 95.9 and -23.7 mEg/kg for the control and lysine-fermentation by-product diets, respectively. Dietary treatments were manufactured at the Kansas State University O.H. Kruse Feed Mill in Manhattan, KS. During bagging of the experimental diets, feed samples were collected from every fifth bag (50 lb), and these samples were pooled and used for nutrient analysis. Duplicate composite samples per dietary treatment were analyzed at a commercial laboratory (Ward Laboratories, Kearney, NE) for dry matter (DM), crude protein (CP), crude fiber, Ca, P, K, S, Cl, Na, and Mg.

From d 110 of gestation until farrowing, sows were fed 6 lb/d of their respective diets. After farrowing, sows were allowed *ad libitum* access to their respective diets. Sows were fed the lysine-fermentation by-product diet until d 10 of lactation, at which point they were switched to the control diet for the remainder of the lactation period.

Urine samples (40 mL) were collected by free-catch in the middle of urination, at d 110 of gestation (pre-treatment) farrowing, d 10 of lactation and at weaning using a 50 mL plastic cup. All samples were measured for pH using a pH meter (Accumet Portable AP62 pH/mV meter, Fisher Scientific, Hampton, NH) and 4 mL of subsampled urine was sent to a commercial laboratory (Microbial Research Inc., Fort Collins, CO) for analysis of a total aerobic bacteria count.

On the day of birth, piglets were weighed and cross-fostered within treatment in an attempt to equalize litter size. Individual sow feed intake measurements were collected

[4]DeRouchey, J. M., J. D. Hancock, R. H. Hines, K. R. Cummings, D. J. Lee, C. A. Maloney, D. W. Dean, J. S. Park, and H. Cao. 2003. Effects of dietary electrolyte balance on the chemistry of blood and urine in lactating sows and sow litter performance. J. Anim. Sci. 81: 3067-3074.
[5]Dee, S. A., and R. Drolet. Year. Diseases of the Urinary System. In: B. E. Straw, J. J. Zimmerman, S. D'Allaire and D. J. Taylor, editors, Diseases of Swine. Blackwell Publishing, Ames, IA. p. 199-215.

by recording the amount of feed provided to each sow and recording feed remaining in the feeder. Litter characteristics were measured on all sows, including stillborn and mummified fetuses, and pre-weaning mortality.

Statistical Analysis

A repeated measures statement, with random effect of block, was used for analyzing urine pH and total aerobic bacteria counts (log transformed). Results were considered significant at $P \leq 0.05$, and marginally significant at $0.05 \leq P \leq 0.10$. Data were analyzed using the GLIMMIX procedure of SAS (Version 9.4, SAS Institute Inc., Cary, NC).

Results and Discussion

Chemical Analysis

Chemical analysis of DM, CP, crude fiber, P, K, and Na in diets were similar to formulated values (Table 3). Chemical analysis of Ca, S, and Cl differed from formulated values in both diets; however, the analyzed values were different by a similar percentage in both diets. Thus, a new dEB was calculated based on the chemical analysis. The dEB values after analysis were approximately 50 mEq/kg lower than formulated, but with similar magnitude of difference between treatments. The dEB was based on analyzed values of 51.5 and -76.2 mEq/kg for the control diet and diet containing the lysine-fermentation by-product, respectively.

Urine Analysis

For analysis of urine pH, as expected, there was no evidence for difference in urine pH ($P > 0.05$) between dietary treatments at d 110 of gestation; however, at farrowing and d 10 of lactation, there was a reduction ($P = 0.001$) in urine pH in sows fed the lysine-fermentation by-product compared to sows fed the control diet. By weaning (d 19) there was no evidence for differences in urine pH observed among the dietary treatments. For urine bacteria concentrations, there was no evidence for treatment difference ($P > 0.05$) in total bacteria count at any measured time point (Table 5).

Observational Data

Because there were not enough sows per treatment to determine the influence of the fermentation by-product on sow performance, means are provided for observational purposes. The average sow parity was 2.2 with a range of 1 to 4. Average daily feed intake was 13.4 lb for sows fed the control diet and 13.8 lb for sows fed the lysine-fermentation by-product diet. Average total born was 16.2 pigs, with 89% (14.4) born alive, 6% stillborn and 5% mummified fetuses. The average number of pigs weaned per litter was 12.7, with weaning occurring on day 19 (± 2 d) of age.

In conclusion, feeding the lysine-fermentation by-product in diets for sows reduced urine pH during the treatment period, but did not affect total bacteria count in the urine. This proof of concept study supported the hypothesis that the lysine-fermentation by-product would reduce sow urine pH and could possibly be used as an ingredient to influence dEB of diets fed to sows.

Table 1. Chemical analysis of lysine-fermentation by-product[1]

Item, %	Amount
Dry matter	53.10
Crude protein	51.86
Crude fiber	0.0
Ether extract	0.18
Ca	0.04
P	0.10
K	0.57
Mg	0.13
S	10.90
Na	0.30
Fe	0.01
Cl	0.81

[1]Analysis provided by Ajinomoto Heartland Inc. (Chicago, IL).

Table 2. Diet composition (as-fed basis)

Ingredient, %	Control	Lysine-fermentation by-product
Corn	63.22	61.33
Soybean meal, 46.5% CP	30.19	30.33
Choice white grease	2.50	2.50
Monocalcium phosphate, 21%	1.30	1.30
Limestone	1.05	1.05
Salt	0.50	0.50
L-Lys-HCl	0.20	0.20
DL-Met	0.05	0.06
L-Thr	0.08	0.08
Trace mineral premix	0.15	0.15
Sow add pack	0.50	0.50
Vitamin premix without phytase	0.25	0.25
Ronozyme HiPhos 2700	0.02	0.02
Lysine-fermentation by-product[1]	---	1.75
Total	100	100
Calculated analysis		
Standardized ileal digestible (SID) AA, %		
Lys	1.07	1.07
Ile:Lys	67	67
Leu:Lys	139	138
Met:Lys	30	30
Met and Cys:Lys	56	56
Thr:Lys	64	64
Trp:Lys	20	20
Val:Lys	73	73
Total Lys, %	1.21	1.21
Net energy, kcal/lb	1,138	1,117
Crude protein, %	19.9	20.7
Ca, %	0.84	0.84
P, %	0.66	0.66
Available P, %	0.45	0.45
Na, %	0.24	0.24
Cl, %	0.53	0.55
K, %	0.88	0.89
S, %	0.13	0.32
dEB,[2] mEq/kg	95.9	-23.7

[1]Lysine-fermentation by-product is from the manufacturing of crystalline lysine (Ajinomoto Heartland, Inc., Chicago, IL).

[2]Dietary electrolyte balance (dEB) ={[(Na/23) + (K/39.1)] – [(Cl/35.5) + (S/16)]} × 10,000.

Table 3. Chemical analysis of the diets (as-fed basis)[1,2]

Item, %	Control	Lysine-fermentation by-product
Dry matter	89.29	88.94
Crude protein	20.05	21.60
Crude fiber	2.35	3.05
Ca	1.10	1.19
P	0.64	0.70
K	0.88	0.90
Mg	0.17	0.18
S	0.23	0.44
Na	0.21	0.20
NaCl	0.70	0.69
Cl	0.43	0.42
dEB,[3] mEq/kg	51.5	-76.2

[1]Diet samples were collected from each batch of feed at manufacturing from every 5th bag, homogenized, and subsampled for analysis.
[2]Proximate and mineral analyses were conducted in duplicate on composite samples (Ward Laboratories, Kearney, NE).
[3]Dietary electrolyte balance (dEB) ={[(Na/23) + (K/39.1)] – [(Cl/35.5) + (S/16)]} × 10,000.

Table 4. Effects of lysine-fermentation by-product in lactation on sow urine pH[1,4]

Sampling time	Control	Lysine-fermentation by-product [2]	SEM	*P*-value
d 110 of gestation	7.30	7.19	0.092	0.2423
Farrowing	7.23	5.90	0.223	< 0.001
d 10 of lactation	7.18	5.16	0.109	< 0.001
Weaning[3]	7.28	7.21	0.125	0.592

[1]A total of 27 mixed parity females were used in a lactation study. Sows were allotted to treatment based on d 110 BW and parity. Sows consumed 6 lb/d from d 111 of gestation until farrowing.
[2]Lysine-fermentation by-product is from the manufacturing of crystalline lysine and added to the diet at 1.75% (as-fed). Sows were fed the lysine-fermentation by-product diet from d 111 of gestation until d 10 of lactation, then control diet from d 10 of lactation to weaning.
[3]Average weaning age of 19 d.
[4]A treatment × day interaction was observed, where sows on the control treatment had no change in pH over time. However, sows on the lysine-fermentation by-product treatment had lower pH on the day of farrowing and d 10 of lactation compared to d 110 of gestation and d of weaning.

Table 5. Effects of lysine-fermentation by-product in lactation on total bacteria count (CFU/ml log_{10}) in urine[1,2]

Sampling time	Control	Lysine-fermentation by-product[3]	SEM	*P*-value
d 110 of gestation	3.62	3.68	0.192	0.772
Farrowing	3.63	3.70	0.266	0.790
d 10 of lactation	3.64	3.51	0.257	0.626
Weaning[4]	3.64	3.27	0.270	0.196

[1]A total of 27 mixed parity females were used in a lactation study. Sows were allotted to treatment based on d 110 BW and parity. Sows consumed 6 lb/d from d 111 of gestation until farrowing.
[2]Log counts were analyzed using pre-planned contrast statements to test for treatment, day, and treatment × day interactions. No evidence for difference was detected.
[3]Lysine-fermentation by-product is from the manufacturing of crystalline lysine, and was added to the diet at 1.75% (as-fed). Sows were fed the lysine-fermentation by-product diet from d 111 of gestation until d 10 of lactation, then control diet from d 10 of lactation to weaning.
[4]Average weaning age of 19 d.