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Water quality is a common concern among swine producers. Highly saline waters are found in many parts of the western half of the United States. Often these are the most readily available or the only sources of livestock water. Of the salts present naturally, chlorides and sulfates predominate. In South Dakota, the salts commonly present at high concentrations in excessively saline waters are sodium sulfate, sodium chloride and magnesium sulfate. Either sodium chloride or sodium sulfate will often account for over 75% of the total salts in these waters, while magnesium sulfate usually accounts for lesser amounts.

The objective of this study was to determine the effects of high sulfate waters given to swine during gestation and lactation and to their offspring when weaned at 28 days. Sodium and magnesium sulfate were selected because of their predominant presence in South Dakota water.

Experimental Procedure

The reproductive trial involved 31 sows and 27 gilts of Hampshire x Yorkshire x Duroc breeding. Sows and gilts were grouped separately on the basis of ancestry and weight and about 30 days postbreeding were randomly assigned to one of the following treatments:

Treatment 1 - Control using the local water supply
Treatment 2 - 1500 ppm added sulfate from sodium sulfate to the local water
Treatment 3 - 3000 ppm added sulfate from sodium sulfate to the local water

Sulfate content was analyzed weekly and the averages with their standard deviations for the entire period are shown in table 1.

The gilts and sows were bred at approximately 8 months, fed 4 lb. of feed per day in individual stalls and housed on dirt lots. The water treatments were provided ad libitum from 80 gallon circular tanks.

At 110 days of gestation, the gilts and sows were moved to the farrowing house and placed in individual crates. They were turned to outside pens for 2 hours in the morning and 1.5 hours in the evening for feed and water. The piglets were provided the same water as their dam from waterers in the creep areas.

The number of live and stillborn pigs as well as litter weight and average pig weight were obtained after farrowing. In addition, number of pigs, litter weight and average pig weight at 28 days were recorded.

The composition of the basal diets is shown in table 2.

To determine the effect of water quality on the offspring after weaning, 54 4-week old pigs, initially averaging 16.5 to 17.5 lb., were allotted into nine groups. Each group consisted of two pigs from each of the three sow treatments and these groups were randomly allotted to three replications of the following treatments:

Treatment 1 - Control water
Treatment 2 - 3000 ppm added sulfate from sodium sulfate
Treatment 3 - 3000 ppm added sulfate supplied equally from magnesium and sodium sulfates

The pigs were housed six to a pen and offered water and an 18% protein, fortified corn-soybean meal diet ad libitum for the 28-day trial.

Weights were recorded and fecal condition was scored on a 1 to 5 basis, with 1 being most firm.

Results and Discussion

Sulfate content of water consumed during gestation had no significant effect on gestation gain, number of pigs per litter at birth (total and live) or average pig and litter birth weights (tables 3 and 4). Lactation gain, number of pigs at 28 days and average pig and litter weights at 28 days were not significantly affected by sulfates in water during lactation. Slightly less saline water was consumed during gestation. However, in lactation, water consumption increased ($P>.05$) as total dissolved solids increased. Gilts consumed more water than sows during gestation but slightly less during lactation.

Significant differences existed in gestation and lactation gain between gilts and sows. Gilts gained more during gestation and also gained an average of 12.1 lb. during lactation, while sows lost an average of 15.4 during this time.

The general condition and performance of the pigs during the 28-day nursing period were similar among groups with no excessive scouring noted in any of the treatments.

No significant differences occurred after 28 days in average daily gain or feed per gain among weaned pigs receiving the control water and those consuming saline water containing 3000 ppm of added sulfates (table 5).

Water consumption increased significantly among treatments with approximately 30% more water consumed by pigs receiving saline water containing sodium and magnesium sulfates and 50% more water consumed by pigs on the sodium sulfate treatment.

A significant difference existed in average fecal condition between pigs receiving control or saline waters. Scouring was considerably more evident during the first 2 weeks in pigs receiving saline water.

Summary

Thirty-one sows and 27 gilts were utilized to study the effect of water quality during gestation and lactation. Sodium sulfate added to the drinking water had no significant effect on gestation or lactation gains, number, weight or health of pigs at birth or at weaning. Water consumption did not differ during gestation but increased during lactation as salt level increased. These results suggest that sulfates up to and including 3320 ppm in water have no significant effect on reproduction in the gilt or sow or on the performance and health of the piglet.

Fifty-four weaned pigs representing the sow treatments equally were utilized in a 4-week study of the effects of added sulfates from sodium sulfate or sodium and magnesium sulfates in drinking water. No significant treatment differences ($P<.05$) occurred in average daily gain or feed per gain. Scouring was more common with fecal condition less firm ($P<.01$) and water consumption greater ($P<.05$) among pigs receiving water with added sulfates. No differences were observed in pigs receiving water containing sodium sulfate or equal parts of sulfate from sodium and magnesium sulfates. These results suggest that water containing up to and including 3320 ppm sulfate has no significant effect on feeder pig performance other than increasing water consumption and looseness of the feces.

Table 1. Total Dissolved Solids, Sulfate and Sodium Concentrations in control and Experimental Waters (ppm)[a,b]

Treatment	Total dissolved solids	Sulfate	Sodium
Control	620	320 (320 ± 24)	20
Low sulfate	2840	1820 (1790 ± 35)	740
High sulfate	5060	3320 (3298 ± 139)	1460

[a] Values for control water by analysis. Values for low and high sulfate treatments were calculated from analysis of the water and the known salt additions.

[b] Averages of weekly analysis for entire period in parenthesis.

Table 2. Composition of Basal Diets (Percent)

Item	Gestation	Lactation
Ground yellow corn	77.6	68.5
Alfalfa meal	10.0	--
Soybean meal (44%)	9.0	--
Soybean meal (48%)	--	18.0
Beet pulp	--	10.0
Dicalcium phosphate	2.3	2.0
Limestone	.5	.8
Trace mineral salt (high zinc)	.5	.5
Premix[a]	.1	.1
Crude protein	12.6	15.7

[a] To supply per lb.: vitamin A, 2000 IU; vitamin D, 200 IU; vitamin E, 2.5 mg; riboflavin, 1.25 mg; pantothenic acid, 5 mg; niacin, 8 mg; choline, 25 mg and vitamin B_{12}, 5 micrograms.

Table 3. Effect of Sulfate Content of Water on Sow Performance

Parameter	Added sulfates (ppm) 0	1500	3000	Gilts	Sows
No. of litters	12	13	14	16	23
Avg. gestation gain, lb.[a]	66.4	60.5	57.2	90.2	40.9
Avg. lactation gain, lb.[b]	3.3	-12.1	3.7	12.1	-15.4
Water consumption, gallons/day					
Gestation	3.5	3.0	2.8	4.0	2.4
Lactation	3.6	3.8	4.4	3.8	4.1

[a] Significant difference (P<.01) between gilts and sows.
[b] Significant difference (P<.05) between gilts and sows.

Table 4. Effect of Sulfate Content of Water on Reproductive Performance

Parameter	Added sulfates (ppm) 0	1500	3000	Gilts	Sows
No. of litters	12	13	14	16	23
No. pigs/litter at birth					
Total	11.1	10.9	10.0	9.8	11.7
Live	9.6	10.0	8.2	8.7	9.9
Avg. pig birth weight, lb.[a]	3.1	3.1	3.3	2.9	3.3
Avg. litter birth weight, lb.	29.7	29.7	26.0	25.5	31.2
No. of pigs at 28 days	6.7	6.9	6.3	6.5	6.8
Avg. 28-day pig weight, lb.	13.4	13.6	13.9	13.4	14.1
Avg. 28-day litter weight, lb.	88.9	92.8	88.4	86.9	93.1

[a] Significant difference (P<.05) between gilts and sows.

Table 5. Effects of Magnesium and Sodium Sulfate Water Treatment on Performance of Weaned Pigs

Parameter	Control	Sodium sulfate[a]	Magnesium-sodium sulfate[a]
No. of pigs[b]	18	18	18
Avg. initial weight, lb.	16.5	17.6	16.9
Avg. final weight, lb.	29.5	33.0	30.4
Avg. daily gain, lb.	.46	.55	.48
Feed per gain	2.25	2.05	2.18
Avg. daily water consumption, gallons	.33[c]	.50[d]	.43[e]
Avg. fecal condition[f]	1.7[c]	3.3[d]	3.6[d]

[a] Three thousand ppm of sulfate.

[b] Three replications of six pigs per treatment. Three pigs died, data not included.

[c,d,e] Means on same line with different superscripts are significantly different ($P<.05$).

[f] Based on a score of 1 to 5 with 1 being firm.