Dietary Sodium Bicarbonate and Stereotypic Behavior of Gestating Sows

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Introduction

Sows in confinement housing systems often perform repetitive behaviors such as bar-biting, sham-chewing and drinker pressing. These behaviors are considered stereotypic; that is, they are "repetitive, relatively invariant behaviors with no obvious function". They are often termed "abnormal" and have been implicated as indicators of poor welfare in many species, including swine. There is evidence that feed restriction plays a significant role in the development of these behaviors, and their prevalence is highest immediately after feeding. In another natural-forager, monogastric animal, the horse, a number of studies suggest that oral stereotypies are associated with feeding concentrates and are also associated with gastric ulceration. Their performance stimulates saliva production and when fed antacids, ulceration of the horse's stomach decreases. Sows are also natural foragers, are restricted-fed a concentrate diet, and are similarly known to have problems with gastric ulceration. Therefore, our working hypothesis was that these oral stereotypies actually functioned to increase saliva flow and buffer stomach acidity. Furthermore, by adding dietary buffer in the form of sodium bicarbonate, we would reduce the amount of oral stereotypic behavior that the sows performed.

Materials and Methods

Sixteen Yorkshire x Landrace sows, housed in gestation crates and fed once per day, were subjected to change in diet for 2 wk of a 6-wk experimental period covering wks 4-10 of pregnancy. During wks 1 & 2 and wks 5 & 6, all sows were fed a control diet of standard commercial ration (Table 1). During wks 3 & 4, all sows were fed a diet containing 2% sodium bicarbonate, at the expense of corn, but identical to the control diet in the other ingredients and total energy content. Behavior and heart rate were recorded continuously on the middle day of each week from ½ h before feeding (7:30am) to 2 h after feeding (10:00am) and analyzed to determine incidence and durations of stereotypic behaviors (sham-chewing, bar-biting, nosing trough, nosing floor, nosing crate, drinker use), time spent in different postures (standing, lying, sitting), time taken to settle down after feeding, and the sows' heart rate responses to feeding. Data from each 2-wk period were combined and the mean taken. Comparisons of dietary treatment were carried out using Friedman ANOVA with dietary treatment as the between-subjects factor, blocked by sow. Post hoc comparisons were carried out using Wilcoxon signed rank tests.

Results

Sows spent 46.2% of the pre-feeding observation period engaged in stereotypic behaviors, these behaviors increased to 55.23% of the post-feeding observation time period ($P<0.05$). The main pre-feeding behaviors were nosing the crate (NC, 11.7%) and sham-chewing (SC, 11.6%). The main post-feeding behaviors were nosing the floor (NF, 22.3%) and SC (10.2%). Pre-feeding, there was an increase in SC over time ($P<0.05$), but no effect of dietary treatment. All other measured behaviors pre-feeding were similar across time and not influenced by dietary treatment. The post-feeding durations of bar-biting (BB) and NF were both lower after the diet

contained bicarbonate (BB wks 1&2 = 330s, wks 3&4 = 166s, wks 5&6 = 175s; P<0.01, NF wks 1&2 = 2010s, wks 3&4 = 1412s, wks 5&6 = 1140s; P<0.05; Figures 1a and 1b), but the post-feeding incidence of nosing the trough increased (wks 1&2 = 192s, wks 3&4 = 514s, wks 5&6 = 559s; P<0.001; Figure 1d). There was no significant effect on SC, but there was a numerical decrease in this behavior after the diet contained bicarbonate (Figure 1c). Also after feeding, sows spent more time using the drinker (P<0.01), more time lying down (P<0.01), less time standing (P<0.01), and were quicker to settle (P<0.001) when the diet contained bicarbonate.

Before feeding, heart rate increased over time (P<0.01) but there was no effect of dietary treatment. During and after feeding, mean heart rates were lowest during wks 1&2 (P<0.05), but were not different between wks 3&4 and wks 5&6. However, during feeding, the peak heart rate response was highest when the diet contained bicarbonate (wks 1&2 = 151.7 beats per minute (bpm), wks 3&4 = 156.6 bpm, wks 5&6 = 150.0 bpm; P<0.05).

Discussion

There was no effect on total incidence of oral and nasal behaviors combined either before feeding or after feeding. Before feeding, sham-chewing increased over time, but diet did not affect individual behaviors. However, stereotypies are most prevalent post-feeding and any beneficial effect of bicarbonate would only be likely to appear post-ingestion. After feeding, sodium bicarbonate decreased bar-biting, decreased floor-nosing, decreased the time taken to settle and decreased the time spent standing. It also increased the time spent lying, increased trough nosing, increased heart rate response to feeding and increased drinker use. Adding dietary buffer did reduce oral stereotypic behavior and encouraged the sows to settle quicker post-feeding. These results indicate that sows may indeed be using oral stereotypies as a mechanism to promote gastric acid buffering, but further investigation is needed to confirm this.

The increases in time spent nosing the trough and in peak heart rates during feeding may indicate that the bicarbonate diet is more attractive than the control diet. Post-feeding heart rates also remain high, even though sows are spending more time lying, perhaps indicating greater arousal caused by the bicarbonate diet. The increase in drinker use or drinking has also been noted in other species fed sodium bicarbonate, and may help to dilute gastric acid and contribute to a feeling of satiety. However, there is also likely to be an increase in manure slurry volume.

Conclusion and Implications

Our results indicate that oral stereotypies performed by sows may in fact have a function. Further work is required to support this statement and to determine whether adding sodium bicarbonate to the diet early in life can reduce the ulcerative consequences of restricted feeding practices. We also need to know any long-term effects on health, welfare and productivity, but dietary manipulation to include acid buffers may reduce sow losses due to gastric ulcers.

Table 1: Ingredient composition of treatment diets

Ingredients, %	**Control Diet Weeks1, 2, 5, 6**	**Bicarbonate Diet Weeks 3, 4**
Corn	84.45	82.45
Soybean Meal, 48% CP	11.26	11.26
Dical. Phosphate	2.45	2.45
Limestone	0.67	0.67
Salt	0.50	0.50
Swine Vit. Premix	0.25	0.25
Swine TM Premix	0.125	0.125
Sow Vitamin Premix	0.25	0.25
Selinium 600 premix	0.05	0.05
Sodium Bicarbonate ($NaHCO_3$)	--	2.00
Calculated Analysis		
Crude Protein, %	12.4	12.4
Lysine, %	0.55	0.55
Threonine, %	0.51	0.51
Tryptophan, %	0.13	0.13
Methionine, %	0.23	0.23
Total Sulfurs, %	0.49	0.49
Ca, %	0.85	0.85
P, %	0.75	0.75
Avail. P, %	0.51	0.51
K, %	0.52	0.52

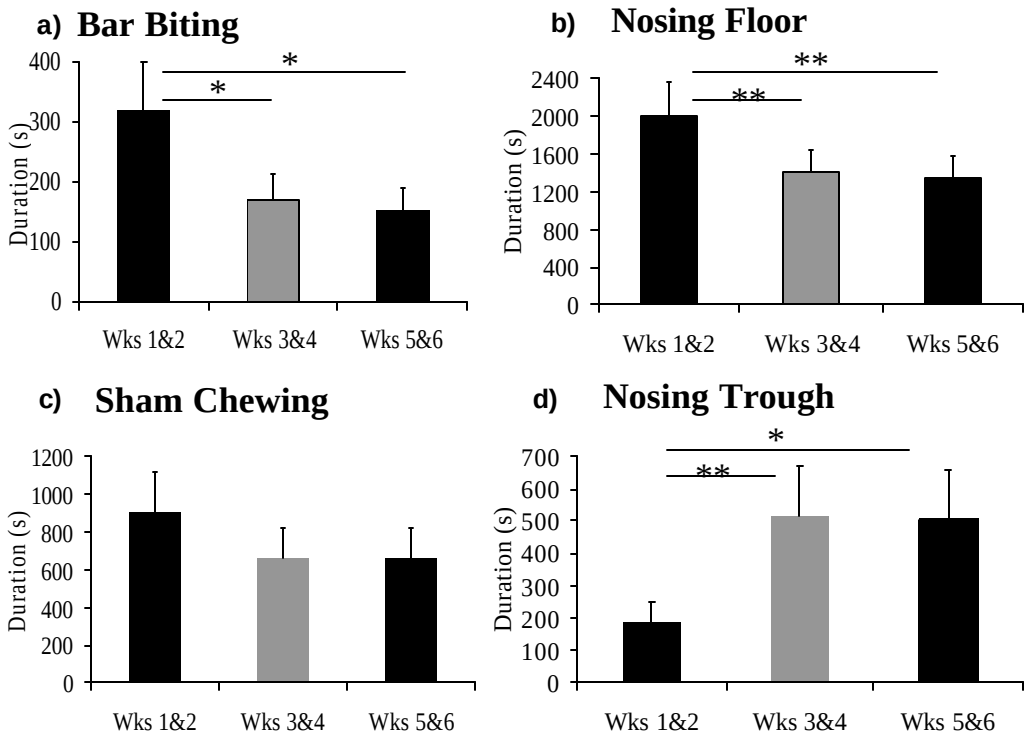

Figure 1. Duration of time spent performing a) bar-biting, b) nosing the floor, c) sham-chewing, and d) nosing the trough in the 2 h post-feeding period, when fed control ( ) and added bicarbonate ( ) diets. Difference in means; * = P<.01, ** = P<.05.