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Effect of feed withdrawal on *Salmonella* colonization at slaughter, meat quality, gut lacerations, and gastric ulcers

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Introduction

To compete in today's global markets, the US pork industry has begun to focus more on the quality and safety of its products. One recommendation that has been made to producers in this regard is to withhold feed from pigs for 12 to 24 hours prior to slaughter, in the belief that this will help reduce the proportion of pale, soft, exudative (PSE) pork.[1] Other potential benefits of withholding feed from pigs prior to slaughter include a decrease in the weight of the gastrointestinal tract at the time of slaughter, which might decrease the possibility of accidental laceration of the tract during evisceration and, thereby, decrease the risk of carcass contamination; a decrease in feed wastage and an increase in yield; and a decrease in the cost of manure treatment at the abattoir.

To our knowledge, however, objective studies of the benefits of withholding feed from pigs prior to slaughter have not been performed. In addition, the practice is associated with some potential disadvantages, including a decrease in live weight, a reduction in meat tenderness and juiciness,[2] an increase in the prevalence of gastric ulcers, and an increase in the proportion of pigs excreting *Salmonella* organisms. Although slaughter equipment is often the immediate source of contamination of pork products, excretion of *Salmonella* organisms by pigs can result in infection of other pigs and contamination of the environment. Thus, any practice that increases the proportion of pigs excreting *Salmonella* organisms is likely to increase the proportion of pork products that are contaminated.

Gastric ulceration is a common condition in pigs raised under intensive management conditions. Abattoir surveys during the past two decades, for instance, have reported that the prevalence of gastric ulcers in pigs ranged from approximately 30% to greater than 90%. One explanation for this wide range is that there are numerous factors associated with the origin of gastric ulcers.[3] In addition, abattoir surveys could be biased depending on the length of time pigs were without feed prior to slaughter because feed withdrawal is one of the predisposing factors. Results from one controlled study[4] of pigs from two commercial herds showed that 11% of the pigs had extensive erosions or ulceration. Additional results from the same study showed that none of the pigs from one herd and only 11% of the pigs from the other herd had grossly normal stomachs.

The cause of gastric ulceration in pigs is not well defined, although numerous factors have been associated with the disease. Risk factors include diet composition and processing, housing density, season, parturition, genetics, and concurrent disease.[3] Reducing particle size of the feed and pelleting both promote gastric ulceration,[5] as does withholding feed for 24 hours.[6,7] For this reason, data from abattoir surveys may be biased, depending on the time between feed removal and slaughter. The outcome following gastric ulceration is variable. At the extremes, the stomach may heal or the ulcer may progress until rupture of underlying blood vessels and death of the animal. The economic loss due to death is easy to measure; however, the economic impact of chronic ulceration is more difficult to measure. For example, gastric ulceration is reported to decrease[4] or have no impact[8] on rate of gain in pigs.

Therefore, before withholding feed from pigs prior to slaughter can be recommended as a standard production practice, the advantages and disadvantages must be more thoroughly evaluated.

Objectives

The objectives of the study were to determine whether withholding feed from pigs for 12 or 24 hours prior to slaughter would have any effects on the following:

- the percentage of pigs with *Salmonella* spp. in cecal contents at the time of slaughter
- meat quality
- the percentage of pigs with lacerations of the gastrointestinal tract during slaughter
- the percentage of pigs with gastric ulcers

Materials and methods

Animals

The experiment was conducted on a commercial farm in North Carolina. A total of 1,133 barrows were weighed, individually identified, and assigned (after blocking by weight) to 36 pens in a 50 X 300 ft curtain-sided finishing building with a 4 ft wide central passageway. Each pen contained 29 to 32 pigs. Mean weight of the pigs at the beginning of the study was 49.3 lb. Pigs were maintained under normal management conditions until three weeks prior to slaughter. Pigs were presumed to be homozygous negative for the HAL 1843 gene because they came from lines that had been DNA tested and found to be negative for this gene. In June, the six pens with the fewest remaining pigs were deleted from the study because they exceeded our needs. Data were collected on pigs in the remaining 30 pens. All pigs were marketed during a three week period in June and July; pigs were individually slap tattooed 24 hours prior to marketing. On May 18 or 19, fecal samples were collected from approximately two-thirds of the pigs in the 36 pens and tested for *Salmonella* organisms. On June 8 or 9, fecal samples were collected from approximately two-thirds of the pigs in the 30 pens remaining in the study. All fecal samples were collected from the rectum with a gloved hand; gloves were changed between pigs. Standard techniques were used to detect *Salmonella* organisms in the fecal samples.

Experimental design

A split-plot design was used for the experiment. The main factor was feed withdrawal time (0, 12, or 24 h). Feed withdrawal times were assigned to pens at random, after blocking of the pens on the basis of prevalence of *Salmonella* shedding, as determined from fecal samples collected during May and June. Feed was withheld by shutting off the feed supply augur and removing any remaining feed from the feeding troughs. The secondary factor was marketing group. Pigs in each pen were marketed in three groups. The first marketing group consisted of the ten pigs in each pen determined to be the heaviest on the basis of a visual appraisal. The second marketing group consisted of the next ten heaviest pigs, and the third marketing group consisted of all remaining pigs. Because feed was withheld from all pigs in each pen prior to removal of each marketing group, feed was withheld once from pigs in the first marketing group, twice from pigs in the second marketing group, and three times from pigs in the third marketing group. We chose to transport and slaughter pigs assigned to all three feed withdrawal times (0, 12, and 24 hours) on the same day to help ensure there were no biases introduced by the way pigs were handled or slaughtered or the way outcomes were measured. However, mixing pigs assigned to all three feed withdrawal times during transport and lairage introduced the possibility of between-treatment cross-contamination of pigs with *Salmonella* spp. Each day, pigs sent to slaughter were transported in a double-deck standard hog trailer that had been pressure-washed and disinfected at the hog-owner's facilities before loading. At the slaughterhouse, pigs used in the study were held in the same pen each day; the pen was washed each day before pigs entered, as per standard operating procedures for the plant. Samples were not collected from the trailer floor or lairage pen to test for *Salmonella* contamination. Time in transport and lairage were recorded. In lairage, pigs had free access to water but not to feed.

Slaughter procedures and collection of cecal contents

Standard evisceration procedures were followed at the plant. The head was removed, the brisket cut open, the abdominal cavity opened, and the rectum (bung) excised. The gastrointestinal tract and thoracic cavity contents (pluck) were then cut from the carcass and placed on a tray. On the tray, the esophagus was cut from the stomach, and the pluck was removed. The gastrointestinal tracts were then removed from the viscera trays, placed in plastic bags, and removed from the processing line. Immediately after the abdomens had been opened, the gastrointestinal tracts had been tagged with numbered tags that correlated with the carcass tattoos. The tracts were then taken to another room in the plant and there trimmed to remove viscera and muscle and weighed. Each tract was visually examined in detail, section by section, and noted which sections (stomach, small intestine, cecum, and colon) were lacerated. The cecum was opened, and at least 10 gm of cecal contents was collected, using a sterilized scoop, and placed in a sterile plastic bag. Bags were weighed at the laboratory, and contents in excess of the required 10 gm were discarded. Standard techniques were used to detect *Salmonella* organisms in samples of cecal contents.

Evaluation of meat quality

Hot carcass weight was determined on the slaughter line. Fat and muscle depth were measured with an optical probe between the 10th and 11th ribs approximately 30 min after stunning. Twenty-four hours after death, one chop was collected from each carcass at a location between the 10th and 11th ribs. After allowing a 20-minute minimum and 25-minute maximum bloom time (the time a freshly cut meat surface is exposed to air), each chop was evaluated for color, drip loss, ultimate pH, and temperature. Lightness, redness, and yellowness of the chop were measured in three locations (medial, middle, lateral), using a chromometer, and mean values were calculated. The chromometer was set to D65 illuminant, a two degree standard observer, using an 8 mm optical port with glass insert, and calibrated with a standard white color plate. A visual color score was also assigned, using a scale from 1 (pale) to 6 (very dark) and plastic Japanese color standards. Japanese color scores are closely related to the lightness score, but the scales are opposite in direction, as a lower lightness score indicates a darker color. Ultimate pH was measured with an electrode and pH meter. Water-holding capacity was evaluated using filter paper to absorb excess fluid on the cut surface; the filter paper was then weighed to determine the increase in weight.

Gastric ulcers

Gastrointestinal tracts were removed from the body cavity, placed on viscera trays and transferred to plastic bags. Stomachs were incised along the greater curvature, opened, and the contents removed prior to evaluation for ulcers. Hot carcass weight was determined on the slaughter line. The nonglandular region surrounding the esophageal entrance to the stomach was inspected visually and assigned an ulcer score. The scoring was from 1 (normal) to 7 (completely ulcerated) using the following criteria:

- grade 1: normal, smooth, glistening white tissue
- grade 2: small degree of hyperkeratosis
- grade 3: more extensive hyperkeratosis
- grade 4: hyperkeratosis with small erosions
- grade 5: erosions covering greater than 25% of the nonglandular region
- grade 6: active ulceration
- grade 7: extensive, active ulceration with epithelium completely sloughed

This scoring system is similar to that reported previously.[9] Gross evaluation of lesions included also noting the presence of cicatrization of tissue around the nonglandular region, an indication of chronic ulcers and esophageal stenosis.

Statistical analysis

All analyses were performed with SAS. Values of $P < 0.05$ were considered significant.

Results

Transport and lairage times

A total of 873 pigs remained in the study and were sent to slaughter. Pigs were loaded and left the farm between 2 and 5 am. Mean transport time was 75 min (range, 48 to 105 min). Mean lairage time was 3.8 h (range, 2 to 4.8 h).

Isolation of *Salmonella* organisms from cecal contents

Salmonella organisms were isolated from cecal samples from 470 of 760 (62%) pigs. Isolation of *Salmonella* organisms was not significantly ($P = 0.29$) associated with feed withdrawal time. The percentage of pigs from which *Salmonella* organisms were isolated decreased significantly ($P = 0.001$) from the first (162/222, 73%) to the second (148/231, 64%) to the third (160/307, 52%) marketing group. However, percentage of pigs from which *Salmonella* organisms could be isolated was not significantly different between pigs from which feed was withheld and control pigs from which feed was not withheld for any of the marketing groups. For the first marketing group, *Salmonella* organisms were isolated from 107 of the 146 (73%) pigs from which feed was withheld and from 55 of the 76 (72%) control pigs ($P = 0.89$). For the second marketing group, *Salmonella* organisms were isolated from 104 of the 152 (68%) pigs from which feed was withheld and from 44 of the 79 (56%) control pigs ($P = 0.06$). For the third marketing group, *Salmonella* organisms were isolated from 111 of the 208 (53%) pigs from which feed was withheld and from 49 of the 99 (49%) control pigs ($P = 0.56$). In May, none of the pigs in one pen were shedding *Salmonella* spp.; between 4 and 50% of the pigs in 27 pens were shedding *Salmonella* spp., and > 51% of the pigs in two pens were shedding *Salmonella* spp. In June, none of the pigs in 17 pens were shedding *Salmonella* spp., and between 4 and 50% of the pigs in 13 pens were shedding *Salmonella* spp. Isolation of *Salmonella* organisms from the cecal contents was not predicted by pen prevalence of *Salmonella* shedding during May ($P = 0.45$) or June ($P = 0.50$).

Meat quality

Meat quality data were collected for 633 pigs. Some carcasses could not be evaluated because of problems at the processing plant, and data for 60 pigs processed during a single day were lost because of an industrial accident at the plant. In addition, meat quality data were not collected on pigs slaughtered on Saturdays. Feed withdrawal time (0, 12, or 24 hours) did not have any significant effects on hot carcass weight, fat depth, or muscle depth (**Table 1**). However, marketing group (1, 2, or 3) was associated with significant linear and quadratic effects on hot carcass weight, fat depth, and muscle depth (**Table 2**), indicating that pigs marketed later were lighter, leaner, and more heavily muscled. Feed withdrawal time was associated with a significant linear effect on redness score, as measured with the chromometer. Marketing group was associated with significant linear and quadratic effects on ultimate pH; with significant linear effects on water-holding capacity, lightness score, redness score, and yellowness score; and with significant quadratic effects on Japanese color score. Feed withdrawal time did not significantly change hot carcass weight in the first marketing group; however, in the second and third marketing groups, an increase in feed withdrawal time was significantly ($P = 0.02$) associated with a decrease in hot carcass weight. In the first and second marketing groups, an increase in feed withdrawal time was significantly (P =

Table 1: Effect of feed withdrawal time on carcass composition and muscle quality of pigs.[a]

	Feed withdrawal time (h)			Pooled
Variable	0	12	24	SEM
Hot carcass weight (kg)	77.6	76.4	75.4	0.5
Fat depth (mm)	20.8	21.3	20.3	0.4
Muscle depth (mm)	47.4	47.3	47.1	0.5
Ultimate pH	5.65	5.66	5.67	0.01
Water-holding capacity (mg)	876	903	828	35
Lightness score	52.7	52.2	51.9	0.3
Redness score[b]	5.42	5.36	4.99	0.11
Yellowness score	4.61	4.49	4.47	0.11
Japanese color score	2.99	3.22	3.18	0.07

aPigs were held in pens with 29 to 32 pigs/pen and marketed over a three-week period. For each pen, feed was not withheld prior to slaughter (n = 214) or was withheld for 12 (n = 210) or 24 (n = 209) hours prior to slaughter.
bSignificant ($P < 0.01$) linear effect of feed withdrawal time.

Table 2: Effect of marketing group on carcass composition and muscle quality of pigs.[a]

	Marketing group			Pooled
Variable	1	2	3	SEM
Hot carcass weight (kg)[b,d]	78.2	79.1	72.1	0.5
Fat depth (mm)[b,d]	21.5	21.5	19.4	0.3
Muscle depth (mm)[b,d]	46.3	46.4	48.6	0.4
Ultimate pH[b,d]	5.70	5.60	5.68	0.01
Water-holding capacity (mg)[b]	617	919	1071	52
Lightness score[b]	49.0	54.5	53.3	0.4
Redness score[c]	5.12	5.49	5.16	0.15
Yellowness score[b]	3.95	5.07	4.55	0.16
Japanese color score[d]	3.2	3.1	3.1	0.08

aPigs were held in pens with 29 to 32 pigs/pen and marketed over a three-week period. Marketing group 1 (n = 211) consisted of the ten heaviest pigs in each pen; marketing group 2 (n = 212) consisted of the next ten heaviest pigs; marketing group 3 (n = 210) consisted of all remaining pigs.
bSignificant ($P < 0.01$) linear effect of marketing group.
cSignificant ($P < 0.05$) linear effect of marketing group.
dSignificant ($P < 0.05$) quadratic effect of marketing group.

0.01) associated with an increase in Japanese color score, but feed withdrawal time was not significantly associated with Japanese color score in the third marketing group.

Gastrointestinal tract lacerations

Data on gastrointestinal tract lacerations were available for 773 pigs. Overall, 120 (15.5%) pigs had lacerations of one or more sections of the gastrointestinal tract. The stomach was lacerated in 65 (8.4%), the small intestines were lacerated in 16 (2.1%), the cecum was lacerated in 7 (0.9%), and the colon was lacerated in 44 (5.7%). Of the 120 pigs with lacerations of one or more sections of the gastrointestinal tract, 113 (94.1%) had lacerations of only one section, and 7 (5.8%) had lacerations of two sections. The proportion of gastrointestinal tracts with lacerations varied from one slaughter day to the next (range, 8.3% to 23.9%), but significant differences among days were not detected ($P = 0.32$). Withdrawal of feed prior to slaughter had a significant effect on weight of the gastrointestinal tract. Mean ± SD weight of the gastrointestinal tract for pigs from which feed had not been withdrawn (16.8 ± 0.13 lb) was significantly ($P < 0.001$) greater than mean weight of the gastrointestinal tract for pigs from which feed had been withheld for 12 hours (14.6 ± 0.13 lb) and mean weight of the gastrointestinal tract for pigs from which feed had been withheld for 24 hours (14.1 ± 0.13 lb). However, mean weight of the gastrointestinal tract was not significantly ($P = 0.07$) different between pigs from which feed had been withheld for 12 hours and pigs from which feed had been withheld for 24 hours.

Feed withdrawal time and marketing group did not have any significant effects on overall prevalence of gastrointestinal tract lacerations. However, the stomach was lacerated in 29 of the 256 (11.3%) pigs from which feed had not been withheld, compared with 36 of the 517 (6.9%) pigs from which feed had been withheld for 12 or 24 hours ($P = 0.03$). When lacerations to the stomach were eliminated (because these lacerations could have occurred off-line when the esophagus was cut from the stomach by plant staff and not during evisceration), the prevalence of gastrointestinal tract lacerations was significantly ($P = 0.005$) higher for the lightest carcasses. Gastrointestinal tract lacerations were identified in 25 of the 174 (14.4%) carcasses that weighed 154 lb, 1 1 of the 191 (5.8%) carcasses that weighed between 156.2 and 167.2 lb, 13 of the 170 (7.6%) carcasses that weighed between 168.3 and 176 lb, and 9 of the 178 (5.1%) carcasses that weighed 178.2 lb. However, prevalence of lacerations in specific sections of the gastrointestinal tract (i.e., small intestine, cecum, colon) was not significantly associated with carcass weight.

Gastric ulcers

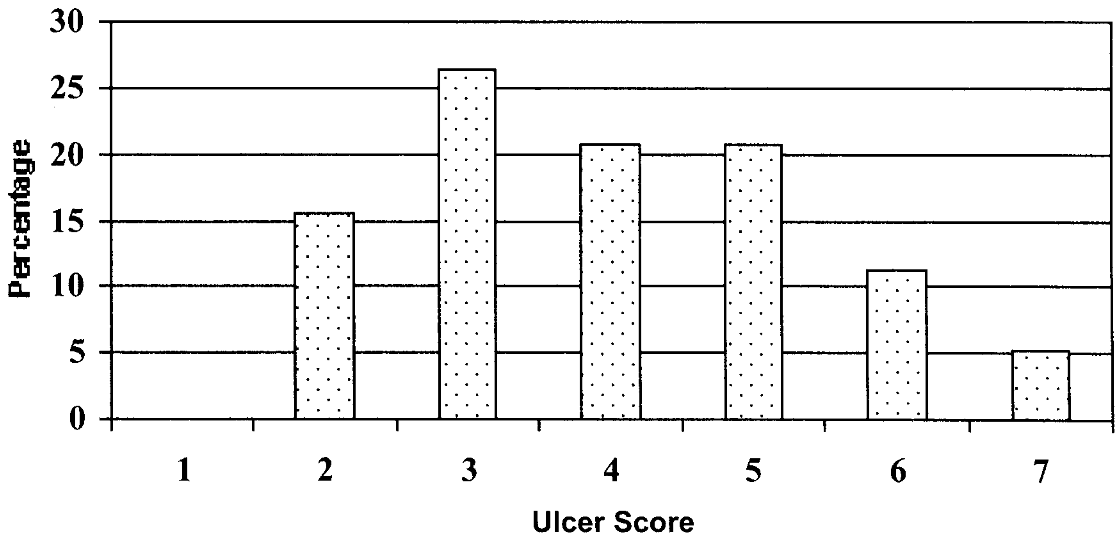
No pigs died during the treatment period as a consequence of stomach ulceration. A total of 754 stomachs were evaluated. Some stomachs could not be evaluated due to problems at the processing plant. On one day during marketing of the second group, data from all pigs processed (n = 60) were lost due to an industrial accident at the plant. Data from additional pigs on other days were lost due to separation of the temporary ID tag from the viscera during processing.

Data in **Figure 1** show the percentage distribution of ulcer scores across all treatments. It is noteworthy that the frequency distribution reflects a relatively normal distribution; however, no pigs were given an ulcer score of 1, which indicates normal healthy tissue. Most of the stomachs evaluated also showed evidence of bile staining. Overall prevalence of lesions (erosions and ulceration) was 58 % (437/754). Average ulcer scores for 0, 12 and 24 h feed withdrawal were 3.9 ± 0.10, 3.6 ± 0.10 and 3.9 ± 0.16, respectively ($P = 0.08$). Results of planned comparisons showed there was no difference ($P > 0.05$) between 0 h and either 12, or 24 h feed withdrawal nor between 12 and 24 h of feed withdrawal. Average ulcer scores increased with each marketing group and were 3.6 ± 0.10, 3.7 ± 0.11, and 4.0 ± 0.09 for marketing group 1, 2 and 3, respectively ($P < 0.01$). There was no interaction between length of feed withdrawal and number of times feed was withdrawn indicating repeated feed withdrawal did not increase stomach damage.

To better understand the effects of treatment on ulcer scores, ulcer scores were grouped as mild (< 4), moderate (4-5.5), and severe (6-7). Overall prevalence of severe ulcers was 16.4% (124/754). There was an increase ($P < 0.01$) in the percentage of severe ulcers in the third marketing group. Neither the distribution of chronic damage nor of esophageal stenosis was affected by length of feed withdrawal; however, both were affected by marketing group ($P < 0.001$). For chronic damage, 57.9% (84/145) of animals having chronic damage were in the third marketing group. Overall prevalence of chronic damage was 19.3% (145/752). For esophageal stenosis, 66.7% (52/78) of animals that had constrictions were in the third marketing group. Overall prevalence of esophageal stenosis was 10.4% (78/752).

Because stomach damage was most extensive in pigs in the third marketing group with no relation to time of feed withdrawal, carcass weight was considered as a variable that might explain the greater prevalence of damage in the third marketing group. Carcass weight was separated into quartiles to examine relationships between carcass weight and stomach damage. The data in **Table 3** show the prevalence for the variables relating to stomach damage in each of the carcass weight subclasses. Prevalence of severity of damage ($P < 0.01$), chronic damage ($P <$

Figure 1: Percentage of pigs with each ulcer score across all treatments (n=752). See text for description of categories.



0.05), and esophageal stenosis (P < 0.001) all increased as carcass weight decreased, most notably for the lowest quartile (**Table 3**).

Discussion

A limitation of our study is that we may have overestimated the true prevalence of cecal *Salmonella* colonization because pigs assigned to all three feed withdrawal times (0, 12, and 24 hour) were transported to slaughter on the same truck and shared the same lairage. The high stocking density, combined with the stress involved, may have led to cross-infection with *Salmonella* spp. among treatment groups. Because the tonsils and mesenteric lymph nodes may harbor *Salmonella* spp. for 28 weeks or longer, ten-some slaughter age pigs exposed to *Salmonella* spp. earlier in life may infect other pigs during the preslaughter period. During transport and lairage, *Salmonella* organisms in the tonsils may reach the colon and rectum in two hours,[11,12] which is less than the five hours these pigs were in transport and lairage. Also, infected pigs can orally infect others during transport,[13] and *Salmonella typhimurium* can be isolated from the cecum and colon three hours after experimental aerosol exposure.[14] In contrast, Isaacson et al.[15] demonstrated in experimentally infected pigs that when feed was withheld prior to slaughter, transportation for four hours (compared with < 15 minutes) did not increase the proportion of pigs with *Salmonella typhimurium* in ileocecal contents. Also, authors of a recent study[16] found that *Salmonella* isolation rates were lower for pigs transported and held in lairage for up to 18 hours than control pigs. Thus, cross-contamination of pigs during transport and lairage may not be an important cause of new infection. In addition, we found that the percentage of cecal samples positive for *Salmonella* spp. decreased in pigs from the first (73%) versus the second (64%) versus the third (52%) marketing group. This pattern is more reflective of the temporal decrease in on-farm isolation than supportive of a presumably constant exposure to contaminated flooring in lairage and associated acute gastrointestinal tract infection.

The proportion of pigs in the present study that had lacerations of the gastrointestinal tract during evisceration (15.5%) was higher than previously reported (4 to 5%).[17] This difference may be attributable to the higher processing speed in the present study (18 pigs/min) or to the more detailed examination of the gastrointestinal tract. As expected, the weight of the gastrointestinal tract was significantly lower in pigs from which feed had been withheld than in pigs from which feed had not been withheld. However, unexpectedly, the prevalence of gastrointestinal lacerations was not associated with feed withdrawal time or marketing group. In fact, when data for stomach lacerations were excluded, the prevalence of gastrointestinal tract lacerations was highest among pigs with the lightest carcass weights. It may be that in this plant, the rhythm of the evisceration process was disrupted by the lighter (presumably shorter) carcasses, resulting in an increase in the number of lacerations. From the perspective of bacterial contamination, an important finding of the present study was the low prevalence of cecal lacerations. In addition, the prevalence of cecal lacerations was not associated with feed withdrawal time or carcass weight.

The distribution of stomach damage in the current experiment is similar to that reported by Elbers et al.[4] There are few studies with which to compare the current results. In one study, including a large data set, prevalence of moderate and severe ulcers was combined into a single category, making comparison difficult due to differences in scoring systems used.[8] Additional data collected from slaughter facilities cannot be evaluated adequately without information on transport and lairage time because they may bias the observations as described by Davies et al.[18]

We expected that there would be a significant effect of feed withdrawal time on stomach damage. There was no difference in the extent of stomach damage in pigs fasted several times compared to the damage in stomachs of pigs

Table 3: Percentage of pigs in the population, listed by weight class, with the specific type of stomach damage.

Variable	Carcass weight, kg (lb)[a]			
	< 71.2 (156.6)	71.2 - 76.1 (156.6 - 167.4)	76.2 - 80.3 (167.6 - 176.7)	> 80.3 (176.7)
Sample size, n	183	181	180	191
Chronic damage [b]	5.99	5.31	4.22	4.08
Esophageal stenosis[b]	4.76	1.77	2.45	1.5
Extent of damage[b]				
Mild	10.34	10.88	12.24	13.61
Moderate	9.25	11.16	8.84	9.93
Severe	5.31	2.60	3.40	2.45

aHot carcass weights (n = 735) were divided into quartiles as noted by the weight ranges.
bPrevalence of chronic damage (P < 0.05), esophageal stenosis (P < 0.001) and severity of damage (P < 0.01) all increased as carcass weight decreased.

that were fasted once and fed a finely ground diet for 28 days before they were killed for stomach evaluation. Thus we did not expect to observe an interaction between length of feed withdrawal and number of times feed was withdrawn; however, because there are so few data evaluating repeated feed withdrawal, it was a variable of interest in the current study. Lack of an interaction suggests that either there was no damage due to feed withdrawal or tissue damaged due to feed withdrawal healed when feeding was restored.

We observed increased prevalence of severe damage, chronic damage, and esophageal stenosis in pigs from the third marketing group, regardless of length of feed withdrawal. These results suggest that producers can withhold feed from pigs prior to slaughter without causing an increase in stomach damage. In addition, these results suggest that there were other overriding factors contributing to stomach damage in the production setting. To date, the etiology of ulceration of the nonglandular region of the pig's stomach is not well defined, although numerous factors are associated with the disease.[3] Straw et al.[7] suggested that any factor that contributed to a disruption in normal feed intake could contribute to development of ulcers. Factors disrupting normal intake would likely also result in decreased rate of gain.

The results of the current study show that stomach damage increased as carcass weight decreased, most notably for the pigs in the lowest quartile. Also, pigs in the third marketing group had lighter carcasses than pigs in the other two marketing groups. Because this was the case for the control pigs that had been exposed to 0 h feed withdrawal as well as those exposed to 12 or 24 h feed withdrawal, the observation is likely unrelated to the treatments used. Whether animals developed lesions and subsequently decreased intake or whether an event occurred that resulted in decreased intake and subsequently lesions developed is not known. However, it was clear from observations of the stomach in some animals that the extent of esophageal stenosis was severe. In some cases the opening into the stomach was barely 0.5 cm which would impede passage of feed into the stomach and be likely to decrease feed intake and gain.

The high prevalence of cicatrization and esophageal stenosis in the current study suggests that some animals recover from an ulcerogenic insult whereas others do not. The factors that contribute to the differing outcomes are not clear. The relation of severity of damage, chronic damage, and esophageal stenosis to carcass weight suggests that the impact of chronic ulcers on growth may be greater than is widely appreciated. Further research into the causes of chronic stomach damage in commercial herds may help explain the current observations.

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Additional information

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