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Health of Finishing Steers: Effects on Performance, Carcass Traits, and Meat Tenderness[1,2]

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ABSTRACT: The impact of respiratory disease during a 150-d feedlot finishing period on daily gain, carcass traits, and longissimus tenderness was measured using 204 steer calves. Feedlot health status was monitored in two ways. First, clinical signs of respiratory infection were evaluated each day; treatment with antibiotic was based on degree of fever (if rectal temperature exceeded 40°C then calves were treated). Steers that were treated (n = 102) had lower ($P < .05$) final live weights, ADG, hot carcass weights (HCW), less external and internal fat, and more desirable yield grades. Steers that were treated had a higher prevalence of carcasses that graded U.S. Standard than steers that were never treated. Second, as an alternative index of health status, lungs of all steers were evaluated at the processing plant using a respiratory tract lesion classification system; this health index included presence or absence of preexisting pneumonic lesions in the anterioventral lobes plus activity of the bronchial lymph nodes (inactive vs active). Lung lesions were present in 33% of all lungs and were distributed almost equally between treated (37%) and untreated cattle (29%). Steers with lesions (n = 87) had lower ($P < .05$) daily gains, lighter HCW, less internal fat, and lower marbling scores than steers without lesions. Compared to steers with lesions but inactive bronchial lymph nodes (n = 78), steers with lung lesions plus active lymph nodes had lower ($P < .01$) ADG and dressing percentage. Longissimus shear force values for steaks aged 7 d were lower ($P = .05$) from steers without lung lesions than those for steaks from steers with lung lesions. Overall, morbidity suppressed daily gains and increased the percentage of U.S. Standard carcasses. Compared to health assessment by clinical appraisal (based on elevated body temperature), classification based on respiratory tract lesions at slaughter proved more reliable statistically and, thereby, more predictive of adverse effects of morbidity on production and meat tenderness.

Key Words: Steers, Feedlots, Morbidity, Health, Performance, Carcass Composition

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Introduction

Economically, the most important disease affecting feedlot cattle throughout North America is the bovine respiratory disease (**BRD**) complex (Martin et al., 1989; Edwards, 1996). This disease complex accounts for approximately 75% of feedlot morbidity and 50% of mortality (Edwards, 1996). Although the medical costs attributable to the treatment of BRD are substantial (Martin et al., 1982; Perino, 1992), the economic impact of BRD on performance may be even more devastating. McNeill et al. (1996) reported that "healthy" steers had higher daily gains (1.33 vs 1.26 kg/d) and 12% more U.S. Choice carcasses than cattle identified as "sick" at some point during the finishing period. Martin et al. (1989), Bateman et al. (1990), and Morck et al. (1993) reported that gains were lower for feedlot cattle treated for BRD. In other studies that based health status on clinical evaluation alone, respiratory morbidity during the finishing phase failed to depress daily gain (Townsend et al., 1989; Griffin and Perino, 1992). Unfortunately, clinical signs of disease may go undetected in feedlot cattle. Wittum et al. (1996) found that even though only 35% of 469 steers were medicated for respiratory disease between birth and slaughter, 72% had

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pulmonary lesions at slaughter. They failed to detect respiratory tract lesions in 28% of the treated cattle; this may indicate that the medical treatment was successful and resulted in resolution of lung damage. But presence of lesions among 68% of the steers in that trial that were never treated reflects diagnostic oversight. Examination of lungs at the time of slaughter may help to detect the existence of prior respiratory events more precisely than clinical examination of live cattle. Our objectives were to evaluate the effects of health on feedlot performance, carcass characteristics, and meat tenderness basing our health status evaluation on 1) clinical appraisal and elevated body temperature and 2) respiratory tract lesions plus bronchial lymph node activity at salughter.

Materials and Methods

This research was conducted at a commercial feed yard and a commercial processing facility where routine livestock handling methods as outlined in the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (Consortium, 1988) were followed.

Feedlot Performance

Spring-born Charolais steer calves (n = 222) from a single South Dakota herd were transported to a commercial feeding facility in southwestern Kansas at weaning. Upon arrival, each steer was weighed, vaccinated with a modified live virus infectious bovine rhinotracheitis (**IBR**), bovine virus diarrhea (**BVD**), bovine respiratory syncytial virus (**BRSV**), *Leptospira pomona* vaccine combination (Bovashield IBBL, Pfizer Animal Health, Exton, PA), implanted with 20 mg of estradiol benzoate plus 200 mg of progesterone (Synovex-S, Fort Dodge Animal Health, Overland Park, KS), and identified with both an electronic identification tag and a numbered ear tag. Animals were placed in a single pen and fed a 13.5% CP steam-flaked corn- and corn silage-based diet (NE_m = 2.23 kcal/kg; NE_g = 1.48 kcal/kg). Steers were revaccinated with a modified live virus IBR, BVD, BRSV, parainfluenza (**PI_3**) vaccine combination (Bovashield 4, Pfizer Animal Health) at 11, 33, and 80 d after arrival due to persistent respiratory disease episodes. On d 80 of the feeding period, each steer was implanted with 120 mg of trenbolone acetate plus 24 mg of estradiol-17β (Revalor-S, Hoechst-Roussel AgriVet, Somerville, NJ). On d 150 108 steers were transported to a commercial packing facility for slaughter; the remaining 107 steers were slaughtered on d 151. Feedlot daily gain was calculated from initial individual animal weights (assumed to be a shrunk weight) and calculated shrunk final individual weight. Shrunk final weight was calculated from d-135 weight (corrected for fill with a 4% pencil shrink) as [initial weight + (ADG to d 135 × days fed)].

Health Evaluation

During the total finishing phase, steers were monitored daily by feedlot personnel for clinical signs of respiratory infection. Rectal temperature for each animal exhibiting respiratory signs (i.e., depression, lack of fill, slow moving, and in some cases nasal and ocular discharge and a soft cough) was measured. Steers that had a rectal temperature greater than 40°C were deemed to be sick, treated with antibiotics using a predetermined protocol developed by the consulting veterinarian, and maintained at the hospital pen for a minimum of 3 d. For statistical analysis, steers were categorized according to the number of times they were treated for respiratory disorders (none, once, and greater than once). Cause of death was determined for the four cattle that died during the finishing period. Two steers died of respiratory disease, one on d 25 and the other on d 71; two steers died of metabolic disorders, one on d 113 and the other on d 117 of the finishing period. Two chronically morbid steers were marketed on d 75 and 82, and one steer was held for residue clearance at the conclusion of the finishing period.

Respiratory Tract Lesions

At slaughter, lung lesions were recorded on a lung-scoring sheet according to lesion type (gross classification) and the lobar location as described by Bryant et al. (1996). Lesions that occurred in the cranial ventral lung lobes were classified as resulting from bronchopneumonia. Lungs with portions or whole lobes missing were classified as having resulted from pneumonia, and the missing lobe was attributed to a previous pneumonia (Bryant et al., 1996; Wittum et al., 1996). Lungs were evaluated for the presence of bronchopneumonia lesions in the anterioventral lung lobes as well as lymph node activity (inactive vs active) based on the size of the bronchial lymph nodes. Each lung that had a lesion was classified as inactive or active based on the size (enlarged) and appearance of the local lymph nodes. Lesions from lungs with inactive lymph nodes presumably reflected a previous case of undifferentiated bovine respiratory disease (**UBRD**) or reflected a lesion that was less severe and resolved more rapidly than lesions from lungs with active bronchial lymph nodes.

Carcass Characteristics and Tenderness Assessment

Carcasses were chilled at 0°C for approximately 36 h, after which USDA quality and yield grade (USDA, 1989) carcass measurements were obtained. The ribeye (10th through 12th rib) lip-on (IMPS 112A; USDA, 1988) was fabricated from the left side of each carcass, vacuum-packaged, and aged for 5 d at 2°C. Samples were frozen for 1 h before fabrication, after which three 2.54-cm-thick steaks were obtained, vacuum-packaged, and assigned to be aged at 2°C for 7, 14, or 21 d. At the end of each assigned aging period, appropriate steaks were boxed, frozen, and maintained at –40°C.

Upon completion of the 21-d aging period, steaks were assigned randomly to be cooked on 1 of 8 d. Twenty-four hours prior to cooking, appropriate vacuum-packaged steaks were placed on metal trays, the vacuum was released, and steaks were tempered at 4°C (AMSA, 1995); no more than 10 steaks were removed from the tempering cooler prior to cooking. Steaks were broiled at 177°C in an impingement oven (Lincoln Impinger, Model 1022) to a final internal temperature of 70°C; temperatures were monitored with copper constantan thermocouples (Model OM-202, Omega Engineering, Stamford, Conn.). After steaks were cooled to 25°C, six cores (1.27 cm diameter) were removed parallel to the longitudinal direction of the muscle fibers. Shear force values were obtained for each steak by shearing each of the six cores once using a Warner-Bratzler attachment to an Instron Universal Testing Machine (Model #4502, Instron, Canton, MA) moving at a crosshead speed of 200 mm/min. The peak force (kg) was recorded with an IBM PS2 (Model 55 SX) using software provided by Instron Corporation; the mean peak force for the six cores was analyzed as an objective measurement of tenderness.

Statistical Analysis

Data were analyzed separately for the effects of health based on clinical evaluations and based on classification of lung lesions at slaughter using least squares procedures (SAS, 1990) with each animal serving as an experimental unit. Contrasts were used to assess differences between untreated and treated cattle as well as to compare those treated once to those treated more than once. Measurements for steers that had lungs without lesions were contrasted with those measurements from steers having lesions; further, measurements from those having lungs with inactive lymph nodes were compared to measurements from those with active lymph nodes. The chi-square analysis (SAS, 1990) was used to detect quality grade and yield grade differences. Probability values reported were generated by SAS (1990). The total data set consisted of 204 cattle for which complete health and carcass data were collected.

Results and Discussion

Mean, minimum, and maximum values for selected live, carcass, and longissimus characteristics are presented in Table 1. Mean initial live weight for the steers was 291 kg; mean weight on d 137 was 517 kg, for an ADG of 1.50 kg/d. Individual dressing percentages ranged from 57.7 to 68.2 and averaged 63.5. Mean adjusted fat thickness was 1.11 cm. As a result of being trim, both externally and internally, and being heavy muscled, mean yield grade was 2.6 as calculated from carcass measurements. Even though marbling score ranged from traces to modest, mean marbling score was 36 percentage points into the slight marbling category. Despite this low mean quality grade (U.S. Select), Warner-Bratzler shear force values were low after only 7 d of postmortem aging.

Performance Traits

The effects of clinical appraisal and elevated temperature on cattle performance and carcass attributes are presented in Table 2. Exactly 50% of the steers were treated for respiratory disease one or more times during the finishing period. Wittum et al. (1996) reported that 35% of the 469 steers in their trial were treated for respiratory disease either prior to weaning, in the feedlot, or both. Wittum and Perino (1995) detected respiratory-related morbidity in 47% of their feedlot steers. Although some researchers suggest that smaller calves are more likely to become sick, initial weights of steers in the various health categories did not differ ($P = .59$). Steers clinically diagnosed with undifferentiated bovine respiratory disease during the finishing phase had lower ($P < .02$) ADG than untreated steers (1.53 vs 1.47 kg/d). For the total 150-d trial, this means that weight gain averaged 9 kg less for steers that had been sick. This resulted in a mean of 7.5 kg lighter ($P < .01$) carcass weights for the steers that received medical treatment for UBRD. A summary of results from the Texas A&M Ranch-to-Rail program (1992 to 1997) revealed that steers treated for health complications during the finishing period had .05 to .25 kg lower ADG than their counterparts that were not treated (Texas A&M, 1992–1997). Similar reductions in gain among treated vs nontreated cattle for respiratory signs have been reported by Van Donkersgoed et al. (1993; 1.11 vs 1.25 kg/d) as well as Wittum and Perino (1995; 1.03 vs 1.07 kg/d). In contrast, other researchers have reported that ADG was not significantly less, for treated than for untreated cattle (1.49 vs 1.51 kg/d, Jim et al., 1993; 1.30 vs 1.32 kg/d, Wittum et al., 1996). This discrepancy among studies regarding the impact of morbidity on feedlot performance may be due in part to differences in 1) case definition, rectal temperature vs clinical signs, 2) viral vs bacterial infection, or 3) precision of clinical appraisal to detect BRD in cattle.

Final weights did not differ ($P = .21$) between steers treated once vs more than once, but steers treated only once gained .14 kg/d (10%) faster than those treated more than once ($P = .04$). This means that for the entire trial weight gain was 21 kg less for steers treated more than once than for those treated only once. These results support those reported by Van Donkersgoed et al. (1993) in which calves treated more than once for BRD had .49 kg/d lower ADG than those treated only once (.70 vs 1.19 kg/d, respectively). Regression analysis revealed that weight gain for the total trial was reduced by 6.43 ± 2.02 kg ($P = .002$) for each day a steer was held in the hospital for treatment of UBRD. Calves that were maintained in hospital pens were fed diets with more hay and, thus, lower in net energy content. Consequently, the reduced daily gain of steers treated for

Table 1. Selected live, carcass, and meat attributes for steers (n = 204) evaluated for respiratory disease

Trait	Mean	Minimum	Maximum	SD
Initial wt, kg	291	229	460	28.91
Final wt, kg	517	395	608	40.20
ADG, kg/d	1.50	.71	2.08	.23
Dressing percentage	63.5	57.7	68.2	1.95
Hot carcass wt (HCW), kg	328.5	238.6	391.5	26.92
Fat thickness, cm	1.11	.20	2.03	.34
Longissimus muscle area (LMA), cm^2	85.3	59.0	104.2	8.10
LMA/100 kg HCW	26.1	16.6	33.1	2.26
Internal fat (KPH), %	2.3	1.0	3.5	.40
Yield grade	2.6	1.3	4.9	.59
Maturity score[a]				
Skeletal	136.6	110.0	180.0	20.27
Lean	144.3	110.0	240.0	18.06
Overall	140.4	110.0	185.0	14.39
Marbling score[b]	335.6	210.0	550.0	42.81
Shear force, kg				
Day 7	3.7	2.3	6.2	.68
Day 14	3.1	2.1	4.8	.47
Day 21	2.9	2.0	4.7	.38

[a]Maturity score: 100 to 199 = A, between 9 and 30 mo of age; 200 to 299 = B, between 30 and 42 mo of age.
[b]Marbling score: 500 = modest^{00}, the minimum required for U.S. Average Choice; 300 = slight^{00}, the minimum required for U.S. Select; 200 = traces^{00}, the minimum required for U.S. Standard.

UBRD might be a result of decreased feed or energy intake; this indicates the importance of timely return to the home pen. Although neither feed intake nor behavior of individual animals was collected in our trial, Sowell et al. (1997) reported that steers treated for clinical disease spent 23% less time eating and made fewer trips to the feed bunk during a 32-d receiving period. The difference in "time-at-the-bunk" was even more pronounced during the first 4 d immediately following feedlot delivery; untreated steers spent 47% more time at the feed bunk during the first 4 d in the feedlot (Sowell et al., 1997).

Among the steers never diagnosed as being sick during the trial, 37% still exhibited respiratory tract lesions, of which 9% had active bronchial lymph nodes. Among steers diagnosed with a respiratory infection, 48% had lung lesions, of which 14% had active bronchial lymph nodes. Wittum et al. (1996) and Bryant et al. (1996) detected pulmonary lesions in 72 and 46% of all lungs evaluated at slaughter, respectively. Wittum et al. (1996) reported that pulmonary lesions were evident among 78% of treated steers and 68% of untreated steers. The high incidence of respiratory tract lesions among steers never diagnosed as having UBRD indicates that either 1) lung damage occurred during an asymptomatic respiratory infection, 2) UBRD occurred prior to the finishing phase and resulted in permanent lung lesions even though the cattle recovered from the overt disease, or 3) respiratory infection resulted from a viral rather than a bacterial infection. The fact that 52% of the cattle treated for UBRD had no lesions reflects 1) detection of a subclinical infection, 2) imprecise clinical diagnosis, 3) full recovery from UBRD and complete resolution of gross lesions, or 4) that the fever detected was in reaction to a viral challenge that caused antibody production (seroconversion) but the animal did not experience clinical disease as detected by anatomic damage.

The effects of respiratory tract lesions on performance and carcass traits are presented in Table 3. For no known reason, initial weights were heavier ($P < .03$) for cattle subsequently detected with lesions as well as for those with active vs inactive bronchial lymph nodes ($P < .02$). In contrast, cattle without respiratory tract lesions at slaughter had the heaviest ($P < .01$) final live weights as a result of 11% (1.58 vs 1.40 kg) greater ($P < .01$) daily weight gains than cattle with lesions. Steers with active bronchial lymph nodes had 18% lower ($P < .01$) ADG than steers with inactive bronchial lymph nodes. These results indicate that cattle recovering from UBRD never compensated for their performance loss during their period of morbidity.

Carcass Traits

Values for carcass traits are shown in Tables 2 and 3. Dressing percentage did not differ ($P = .31$) between untreated and treated steers; however, as a result of lighter ($P < .02$) final live weights (Table 2), steers treated for UBRD had 2.3% (7.5 kg) lighter ($P < .01$) carcass weights. This estimate of dressing percentage could be biased if the steers with active bronchial lymph nodes gained less than other steers from d 135 until slaughter. Carcasses from untreated steers were fatter both externally ($P < .01$), based on subcutaneous fat measurements, and internally ($P < .05$), based on percentage of kidney, pelvic, and heart fat, and tended to have larger (P = .12) longissimus muscle areas than those carcasses from treated steers. Consequently, steers not treated during the finishing period had higher (P < .04) USDA yield grades than steers treated for UBRD; longissimus muscle area/100 kg hot carcass weight did not differ (P = .28) between the two groups. Interestingly, cattle treated for UBRD at the feed yard tended to have the most advanced skeletal maturity scores (P < .10) but the most desirable lean maturity scores (P = .04). As a result, no difference (P = .67) in overall maturity was observed between "sick" and "healthy" steers. The slight reduction in marbling score for steers treated for UBRD compared to those steers that were not treated (338 vs 334; P = .16) resulted in a higher percentage of carcasses being graded U.S. Choice and U.S. Select among steers not treated and more carcasses being graded U.S. Standard among steers treated for UBRD. However, mean quality grade did not differ (P = .93) when analyzed using the chi-square analysis of SAS. These results support the conclusions of McNeill et al. (1996) that steers not treated for respiratory illness produced a higher percentage of U.S. Choice carcasses than those steers that were treated.

Differences in carcass traits between steers treated for UBRD once vs those treated for UBRD more than once (Table 2) resembled differences between untreated and treated steers. Steers treated for UBRD only once had a higher dressing percentage (P < .06) and yielded heavier carcasses (P < .07) that were fatter externally (P < .01) and internally (P < .01) than steers treated more than once. Because their carcasses were leaner and lighter, steers treated for UBRD more than once tended to have more desirable yield grades than those treated only once (P = .07). This yield grade difference may be attributed partly to the greater mean carcass weight of the steers treated only once for UBRD. No differences in longissimus muscle area (P = .30) or skeletal (P = .22), lean (P = .39), or overall maturity scores (P = .87) were detected between steers treated once and those steers treated more than once. Although not statistically significant, cattle treated for UBRD more than once tended to have lower marbling scores than those treated only once (P = .15). This difference in mean marbling score resulted in steers treated for UBRD more than once having the highest percentage of U.S. Standard carcasses.

Steers with respiratory tract lesions had a lower (P = .02) dressing percentage than those steers without lesions. The contrast between animals without vs those with lesions revealed that carcasses from steers without lesions at harvest were heavier (P < .01) and had more external (P = .14) and kidney, pelvic, and heart fat (P < .01). Longissimus muscle area tended to be greater (P = .15) for unaffected steers, but because of the large

Table 2. Performance and carcass traits for steers treated or not treated for respiratory disease

	Times treated for respiratory disease				Significance of contrast[a]	
Trait	0	1	>1	SE	0 vs T	1 vs >1
No. of steers	102	89	13			
Initial wt, kg	293.2	287.6	293.2	5.23	.594	.521
Final wt, kg	523.2	512.9	497.9	7.19	.013	.205
ADG, kg/d	1.53	1.49	1.35	.04	.012	.035
Dressing percentage	63.5	63.7	62.6	.35	.306	.056
Hot carcass wt (HCW), kg	332.2	326.6	311.8	4.80	.007	.062
Fat thickness, cm	1.17	1.09	.76	.06	.001	.001
Longissimus muscle area (LMA), cm^2	86.0	85.0	82.5	1.46	.117	.304
LMA/100 kg HCW	25.9	26.1	26.7	.41	.280	.385
Internal fat (KPH), %	2.3	2.3	1.9	.07	.042	.002
Yield grade	2.6	2.6	2.2	.11	.033	.074
Maturity score[b]						
Skeletal	142.8	144.9	151.5	3.26	.095	.219
Lean	139.4	134.4	129.2	3.64	.036	.390
Overall	141.1	139.7	140.4	2.61	.669	.867
Marbling score[c]	337.5	336.0	317.7	7.23	.161	.152
Quality grade						
Choice, %	4.9	4.5	.0			
Select, %	82.4	83.2	76.9			
Standard, %	12.8	12.4	23.1			
Yield grade						
1, %	13.7	19.1	38.5			
2, %	58.8	62.9	46.2			
3, %	26.5	18.0	15.4			
4, %	1.0	.0	.0			

[a]Contrasts: 0 vs T = steers never treated vs all treated steers; 1 vs >1 = steers treated once vs steers treated more than once.
[b]Maturity score: 100 to 199 = A, between 9 and 30 mo of age.
[c]Marbling score: 300 = slight^{00}, the minimum required for U.S. Select.

Table 3. Performance and carcass trait values for steers with or without respiratory tract lesions

Trait	Respiratory tract lesion[a] None	Inactive	Active	SE	Significance of contrast[b] None vs L	NA vs A
No. of steers	117	78	9			
Initial wt, kg	289.4	290.0	315.0	6.00	.022	.014
Final wt, kg	526.5	505.5	495.4	8.06	.001	.463
ADG, kg/d	1.58	1.43	1.17	.04	.001	.001
Dressing percentage	63.6	63.6	61.8	.40	.021	.008
Hot carcass wt (HCW), kg	334.8	321.5	306.9	5.44	.001	.111
Fat thickness, cm	1.15	1.06	1.04	.08	.133	.891
Longissimus muscle area (LMA), cm^2	86.6	83.4	85.2	1.68	.148	.531
LMA/100 kg HCW	25.9	26.0	27.9	.47	.019	.016
Internal fat (KPH), %	2.3	2.2	2.0	.08	.002	.203
Yield grade	2.6	2.5	2.4	.12	.213	.511
Maturity score[c]						
Skeletal	144.1	145.1	140.0	3.81	.670	.422
Lean	139.0	132.7	138.9	4.23	.427	.383
Overall	141.5	138.9	139.4	3.03	.410	.916
Marbling score[d]	340.1	332.6	303.3	8.89	.009	.051
Quality grade						
Choice, %	5.1	3.8	.0			
Select, %	86.3	78.2	66.7			
Standard, %	8.6	18.0	33.3			
Yield grade						
1, %	15.4	20.5	22.2			
2, %	59.0	60.3	66.7			
3, %	25.6	18.0	11.1			
4, %	.0	1.3	.0			

[a]Respiratory tract lesion: none = no lung lesions of any type present; inactive = presence of a healed lesion from a previous respiratory infection; active = lesion and active lymph node, reflecting active respiratory infection.
[b]Contrasts: None vs L = steers without respiratory tract lesions vs all with respiratory tract lesions; NA vs A = steers with inactive lymph nodes vs those with active lymph nodes.
[c]Maturity score: 100 to 199 = A, between 9 and 30 mo of age.
[d]Marbling score: 300 = slight^{00}, the minimum required for U.S. Select.

Table 4. Warner-Bratzler shear values for steers treated or not treated for respiratory disease

Trait	Times treated for respiratory disease 0	1	>1	SE	Significance of contrast[a] 0 vs T	1 vs >1
No. of steaks	102	89	13			
Shear force, kg						
7 d	3.6	3.8	3.7	.12	.402	.555
14 d	3.1	3.1	2.9	.08	.213	.110
21 d	2.8	2.9	3.0	.07	.169	.371
< 3.84 kg, %						
7 d	68.6	59.6	62.2			
14 d	89.2	95.5	100.0			
21 d	100.0	98.9	100.0			
> 4.5 kg, %						
7 d	9.8	14.6	7.7			
14 d	.0	1.1	.0			
21 d	.0	1.1	.0			

[a]Contrasts: 0 vs T = steers never treated vs all treated steers; 1 vs >1 = steers treated once vs steers treated more than once.

Table 5. Warner-Bratzler shear values for steers with or without respiratory tract lesions

Trait	Respiratory tract lesion[a]			SE	Significance of contrast[b]	
	None	Inactive	Active		None vs L	NA vs A
No. of steaks	117	78	9			
Shear force, kg						
7 d	3.6	3.8	4.0	.14	.051	.350
14 d	3.1	3.1	3.2	.10	.511	.857
21 d	2.8	2.9	3.0	.08	.156	.184
< 3.84 kg, %						
7 d	68.4	60.3	55.6			
14 d	94.0	89.7	100.0			
21 d	100.0	98.7	100.0			
> 4.5 kg, %						
7 d	10.3	12.8	22.2			
14 d	.0	1.3	.0			
21 d	.0	1.3	.0			

[a]Respiratory tract lesion: none = no lung lesions of any type present; inactive = presence of a healed lesion from a previous respiratory infection; active = lesion and active lymph node, reflecting active respiratory infection.

[b]Contrasts: None vs L = steers without respiratory tract lesions vs all with respiratory tract lesions; NA vs A = steers with inactive lymph nodes vs those with active lymph nodes.

difference in carcass weight, those steers not having pulmonary lesions had smaller longissimus muscle area/100 kg hot carcass weight ($P = .02$) than steers with lesions. Differences between steers with inactive bronchial lymph nodes and active lymph nodes were noted for dressing percentage ($P < .01$), hot carcass weight ($P = .11$), and longissimus muscle area/100 kg hot carcass weight ($P = .02$). Although no differences ($P > .38$) in skeletal, lean, or overall maturity scores were evident, carcasses from steers without lesions had a greater ($P < .01$) degree of marbling than carcasses from steers with lesions. Carcasses from steers with lesions and no bronchial lymph node activity tended ($P < .06$) to have higher marbling scores than carcasses from steers with lesions and active bronchial lymph nodes. Consequently, steers that had lungs with active bronchial lymph nodes produced a higher percentage of U.S. Standard carcasses at the expense of U.S. Choice and U.S. Select carcasses; chi-square analysis tends to support the suggestion of a lower ($P < .07$) quality grade for steers with active bronchial lymph nodes.

Longissimus Properties

Values for shear force and percentage of steaks that, based on taste panel evaluation, might have been classified as tender (< 3.84 kg shear force) and tough (> 4.5 kg shear force) are presented in Tables 4 and 5. No effects of previous health status on shear force values for steaks aged 7, 14, or 21 d were detected when steers were classified based on the number of times they were treated for UBRD (Table 4). However, a difference ($P < .06$) in shear force for steaks aged 7 d was detected when steers were classified by respiratory tract lesions; steaks from steers without lung lesions were more tender than steaks from steers with lung lesions (Table 5). Beyond 7 d of postmortem aging, differences in shear force were no longer ($P > .15$) detected. Differences in shear force at 7 d might be attributed in part to the difference in marbling score; shear force was reduced by .003 ± .001 kg ($P = .002$) for each degree increase in marbling score when marbling was based on a scale of 100 per quality grade.

Implications

Respiratory morbidity depressed performance of beef steers, reducing carcass weight, fat deposition, and longissimus muscle area. Performance traits were correlated more closely with respiratory tract lesions at slaughter than with evaluation by clinical appraisal. Steers with respiratory tract lesions, especially when combined with active bronchial lymph nodes, had markedly depressed performance and carcass quality. Although treatment for respiratory disease did not decrease tenderness of longissimus steaks, steaks from steers that had respiratory tract lesions had higher shear force values following 7 d of postmortem age. The high incidence of lung lesions (37%) present in steers never diagnosed as having undifferentiated bovine respiratory disease indicates that 1) respiratory infections were not detected by feedlot personnel, 2) respiratory disease occurred before cattle entered the feedlot, or 3) respiratory infection resulted from a viral rather than a bacterial infection.

Literature Cited

AMSA. 1995. Research guidelines for cookery, sensory evaluation, and instrumental tenderness measurements of fresh meat. American Meat Science Association, Chicago, IL.

Bateman, K. G., S. W. Martin, P. E. Shewen, and P. I. Menzies. 1990. An evaluation of antimicrobial therapy for undifferentiated bovine respiratory disease. Can. Vet. J. 31:689–696.

Bryant, L. K., L. J. Perino, D. D. Griffin, A. R. Doster, C. E. Dewey, and T. E. Wittum. 1996. A proposed method for lesion recording, and lesion effects on calf growth and carcass traits. Proc. Am. Assoc. Bov. Pract. pp 147–151.

Consortium. 1988. Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching. Consortium for Developing a Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching, Champaign, IL.

Edwards, A. J. 1996. Respiratory diseases of feedlot cattle in the central USA. Bovine Pract. 30:5–7.

Griffin, D. D. and L. J. Perino. 1992. Disease monitoring in packing houses. Proc. Am. Assoc. Bov. Pract. pp 343–350.

Jim, G. K., C. W. Booker, C. S. Ribble, P. T. Guichon, and B. E. Thorlakson. 1993. A field investigation of the economic impact of respiratory disease in feedlot calves. Can. Vet. J. 34:668–673.

Martin, S. W., K. G. Bateman, P. E. Shewen, S. Rosendal, and J. G. Bohac. 1989. The frequency, distribution, and effects of antibodies to seven putative respiratory pathogens, on respiratory disease and weight gain in feedlot calves in Ontario. Can. J. Vet. Res. 53:355–362.

Martin, S. W., A. H. Meek, D. G. Davis, J. A. Johnson, and R. A. Curtis. 1982. Factors associated with mortality and treatment costs in feedlot calves: The Bruce County beef project, years 1978, 1979, 1980. Can. J. Comp. Med. 46:341–349.

McNeill, J. W., J. C. Paschal, M. S. McNeill, and W. W. Morgan. 1996. Effect of morbidity on performance and profitability of feedlot steers. J. Anim. Sci. 74(Suppl. 1):135.

Morck, D. W., J. K. Merrill, B. E. Thorlakson, M. E. Olson, L. V. Tonkinson, and J. W. Costerton. 1993. Prophylactic efficacy of tilmicosin for bovine respiratory tract disease. J. Am. Vet. Med. Assoc. 202:273–277.

Perino, L. J. 1992. Overview of the bovine respiratory disease complex. Compend. Cont. Educ. Pract. Vet. 14(Suppl.):3.

SAS. 1990. SAS User's Guide: Statistics (Version 5 Ed.). SAS Inst. Inc., Cary, NC.

Sowell, B. F., J.G.P. Bowman, C. Huisma, M. E. Branine, and M. E. Hubbert. 1997. Feeding behavior of feedlot cattle. Proc. Southwest Nutrition and Management Conference, Phoenix, AZ.

Texas A&M. 1992–1997. Ranch-to-Rail—North/South summary reports. Texas Agricultural Extension Service, Texas A&M University, College Station.

Townsend, H.G.G., A. H. Meek, T. G. Lesnick, and E. D. Janzen. 1989. Factors associated with average daily gain, fever, and lameness in beef bulls at the Saskatchewan Central Feed Test Station. Can. J. Vet. Res. 53:349–354.

USDA. 1988. Institutional meat purchase specifications of fresh beef. Agric. Marketing Serv., USDA, Washington, DC.

USDA. 1989. Official United States standards for grades of carcass beef. Agric. Marketing Service, USDA, Washington, DC.

Van Donkersgoed, J., F. J. Schumann, R. J. Harland, A. A. Potter, and E. D. Janzen. 1993. The effect of route and dosage of immunization on the serological response to a *Pasteurella haemolytica* and *Haemophilus somnus* vaccine in feedlot calves. Can. Vet. J. 34:731–735.

Wittum, T. E. and L. J. Perino. 1995. Passive immune status at postpartum hour 24 and long-term health and performance of calves. Am. J. Vet. Res. 56:1149–1154.

Wittum, T. E., N. E. Woollen, L. J. Perino, and E. T. Littledike. 1996. Relationships among treatment for respiratory tract disease, pulmonary lesions evident at slaughter, and rate of weight gain in feedlot cattle. J. Am. Vet. Med. Assoc. 209:814–818.