Effects of Pre-shipping Management on the Performance of Florida Beef Calves in the Receiving Feedlot

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Introduction

The 2002 USDA Consensus of Agriculture reported a total of 160 beef cow/calf ranches in the US with greater than 2,500 cows. Of these 160 ranches, 60% reside in just four states with Florida, Texas, Nebraska and New Mexico possessing 38, 28, 19, and 10, respectively. These results illustrate a significant anomaly when considering the fate of weaned feeder calves from these major calf producing states. Texas, Nebraska, and New Mexico each have a developed feedlot industry as well as being located to neighboring states also with significant feedlot resources. Florida, on the other hand, has no commercial feedlot industry. All the weaned feeder calves are transported out of Florida for further feeding and marketing. The primary receiving state for Florida-born beef calves is Texas, a distance of over 2,400 km. The vast majority of these feeder calves are born and raised on ranches in south Florida, with other 70% of Florida's 1 million cows residing in counties within 175 km of UF-IFAS, Range Cattle REC. This isolation in Florida's peninsular region creates a unique experience for both environmental and transportation stress considerations impacting weaned calves.

Three of the most stressful events encountered by a feeder calf are weaning, transportation, and feedlot entry. These events lead to multiple physiological, nutritional, and immunological changes in the calf (Loerch and Fluharty, 1999). To further complicate this issue, our normal production management systems often link these events very close in a calf's lifetime, in many cases within only 1 to 3 days. These events have the potential to create multiple detrimental impacts upon the calf, many of which are unavoidable. Some of these include, but are not limited to, 1) dehydration, 2) abrupt change in diet, 3) change in social order, 4) exposure to novel pathogens, and 5) major weather changes. There are an array of potential outcomes to these stressors, with the most severe being death. The final resulting outcome will always be the overriding balance between the cumulative level of stress imposed and the individual resistance of the calf. One of the two will ultimately win out. In typical production systems we recognize when the stressor wins out as an incidence of morbidity, but how much production loss do we incur during the balancing act between stress and resistance?

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This paper provides a review of three studies conducted at the University of Florida – IFAS, Range Cattle Research and Education Center. The studies were designed to evaluate responses to production management scenarios that may impact performance of weaned, transported beef calves. In each study, a transportation simulation was created to mimic the conditions that may be experienced by a weaned, Florida beef calf being shipped to the western high-plains.

The Acute Phase Protein Response

The acute phase protein response is an important component of each of the three studies being presented in this paper and requires initial explanation. The acute phase response is an important early physiological response to inflammatory stimuli (Baumann and Gauldie, 1994). In response to a stress stimuli, blood concentrations of acute-phase proteins increase in cattle (Conner et al., 1988). These proteins are produced from hepatocytes following direct stimulation from proinflammatory cytokines; predominately, interleukin-1, interleukin-6, and tumor necrosis factor (Richards et al., 1991; Breazile, 1996). These proinflammatory cytokines are highly pleiotropic and significant evidence exits suggesting that they can directly inhibit animal growth (Johnson, 1997; Johnson, 1998; Klasing and Korver, 1997). An example includes the increased proteolysis mediated by proinflammatory cytokines, whereas the amino acids liberated from body tissues are likely being incorporated into acute-phase proteins by the liver (Johnson, 1997). This activated immune response results in an increase in nutrients required for the production of inflammatory products, as well as replenishing lost body tissue mass. Given the nature of the response, it is reasonable to expect that an activated inflammatory reaction is acting as a nutrient sink, resulting in reduced body weight gain in stressed calves. Although numerous acute phase proteins have been identified in mammals, our laboratory focuses on four major proteins recognized to be responsive to stress episodes in cattle. These include; 1) ceruloplasmin, 2) fibrinogen, 3) haptoglobin, and 4) acid soluble protein (predominantly α-acid glycoprotein in cattle).

Study 1: Acute Phase Protein Response in Transported Calves

In the first study of this series (Arthington et al., 2003), our objectives were to evaluate the effects of transportation and commingling on the acute phase protein response of newly weaned beef calves. This study was conducted over two consecutive years using 32 and 36 calves in years 1 and 2, respectively. Treatments were applied to calves in a 2 x 2 factorial arrangement (transportation x commingling). Transportation in this initial study was short by Florida standards (3 and 6 h for years 1 and 2, respectively). Commingling was achieved by placing out-sourced calves with study calves during the conduct of the experiment. For the purposes of this paper, only the results pertaining to the main effect of transportation are presented.

All calves experienced an increase in acute phase protein concentrations following weaning, (Tables 1 and 2) but transportation accentuated this increase only in year 1. This difference among years is probably due to the relatively short duration of transportation experienced by these study calves (3 and 6 h for years 1 and 2, respectively). Nevertheless, calves in both years experienced increases in acute phase protein concentrations through subsequent sample collection days following separation of the calf from his/her dam (weaning). This process resulted in an inflammatory stress that was significant enough to elicit the acute phase response. This inflammatory stress could be the result of a combination of many factors, not necessarily pathogenic in nature, such as social disorder, depression, and fasting or abrupt dietary change.

There were no incidences of morbidity in this study, suggesting that the innate resistance of the calves was sufficient to overcome the inflammatory stress challenge. However, how much performance was lost in the early weeks following weaning as result of fueling the energy and nutrient demands of an inflammatory reaction? The following two studies examine this question more thoroughly.

Study 2: Effects of Early Calf Weaning on Responses to Long-Haul Transportation Stress

The second study of this series (Arthington et al., 2005) evaluated the performance of early- versus normal-weaned calves through receiving, growing, and finishing phases of the feedlot. The management process of early calf weaning has been an important research topic of our laboratory for several years. The original emphasis of this management process was placed on 2-year old heifers calving for their first time. The slower maturing Brahman influence of these heifers coupled with the limited quality of tropical forages of our region often limits the re-breeding success of these young females. We have found that the process of early calf weaning (70 to 90 days of age) results in exceptional reproductive performance in these young cows (Arthington and Kalmbacher, 2003; Arthington and Minton, 2004). More surprisingly, later research has shown that the early-weaned calf can be highly productive if managed correctly to address their increased nutritional needs. In 2003, we formed collaboration with Dr. Jerry Spears (North Carolina State University) to examine the performance early- versus normal-weaned calves when transported from south Florida to a research feedlot in North Carolina.

Forty crossbred steers were categorized by age at weaning; 1) Early-weaned; n = 20, and 2) Normal-weaned; n = 20. The average age at weaning was 89 and 300 days for early- and normal-weaned steers, respectively. Early-weaned steers were supplemented on pasture at the ranch of birth from the time of early weaning until shipping. Shipping occurred on the day of normal weaning. Calves were transported on a commercial livestock trailer to Butner, North Carolina, a distance of approximately 1,200 km. Calves remained on the livestock trailer for a full 24-h before unloading. Calf body weight and blood samples were collected at d 0 (ranch or origin), day 1 (unloading in North Carolina), and day 3, 7, 14, 21, and 28. In the feedlot, calves were allocated into four pens per weaning treatment and individual dry matter intake per pen was recorded daily. Calves were slaughtered on two separate dates dependent upon the degree of backfat thickness (215 and 250 days on feed; approximately ½ of steers per treatment on each date).

Early-weaned steers experienced a two-fold improvement in feed conversion compared to normal-weaned steers during the first 28 days in the feedlot (Table 3). This response was not a result of increased feed intake, as no differences were detected in voluntary feed intake among treatments during the 28 day receiving period (Table 3). We attribute this response to at least two potential factors. Firstly, the early-weaned calves likely had a more developed rumen. They had been exposed to concentrate supplement (1% of body weight) for 210 days prior to shipping. This factor may have influenced their greater initial ability to convert feed into body weight gain upon entry into the feedlot. Secondly, and probably more important, the early-weaned calves experienced a greatly reduced inflammatory response following feedlot entry compared to their normal-weaned contemporaries (Figure 1). Again, the calves in this study experienced no instances of morbidity, but the underlying inflammatory reaction, experienced to a greater degree by the normal-weaned calves, very likely drained energy and nutrients away from body weight gain toward the production of inflammatory products, such as acute phase proteins (Johnson, 1997).

Study 3: Effects of pre-weaning management (early-weaning, 45-day pre-weaning, and creep feeding) on response to long-haul transportation stress

In the final study of this series (Data Unpublished), we examined the effects of three weaning management scenarios on measures of stress and productivity of beef calves following a long-haul simulation. This study was conducted over two consecutive years in cooperation with the faculty at the USDA-ARS Station, Brooksville, FL. Brangus-crossbred calves were assigned to one of four weaning management scenarios, involving:

1) Early weaned: Calves permanently separated from their dam at approximately 80 days of age and maintained on pasture while receiving supplement at a rate of 1% of body weight daily.

2) Creep fed: Calves provided free-choice access to creep feed prior to transport (45 and 52 days in years 1 and 2, respectively).

3) Pre-weaned: Calves permanently separated from their dam at 45 and 52 days prior to transport in years 1 and 2, respectively, and maintained on pasture with supplemental feed (10 lb daily).

4) Control: Calves weaned from their dam on the day of transport.

On the day of transport, all calves were loaded onto a commercial livestock trailer and transported within the state of Florida for 1,600 km. Calves remained on the trailer for a full 24 hours before being unloaded into the research feedlot at Brooksville, FL. Calf body weight and blood samples were collected at day 0 (ranch or origin), day 1 (unloading at feedlot), and day 4, 8, 15, 22, and 29. Calves were allocated into 16 pens within weaning treatment (n = 4 and 2 calves/pen for years 1 and 2, respectively).

Previous research has indicated that stress may influence a calf's dietary preference among forage versus concentrates (Lofgreen, 1983), therefore, in the current study hay and concentrate were provided free choice in separate areas of the bunk and dry matter intake of each was recorded daily.

Prior to transport all calves remained in a single group within treatment providing no replication within year; therefore, statistical comparisons of treatment means were not conducted prior to shipping. Actual means ± (stnd. dev.) are provided in Table 4. Averaged over the two years of the study, pre-weaned and creep-fed calves consumed an average of 432 (8.9 lb/d) and 264 lb (5.4 lb/d) of feed, respectively, equating to a total feed cost per calf of $56 and $34, respectively. Early-weaned calves differed considerably compared to the other treatments since they had been weaned for over 200 days prior to transport. Our typical costs to keep an early-weaned calf over this period of time is about $112 ($0.38 per lb of gain), including feed, pasture maintenance, and miscellaneous variable expenses (fencing, mineral salt, etc.).

In year 1, there was a greater amount of body weight shrink in early-weaned vs. control and also in pre-weaned vs. creep-fed calves. The numeric trend continued in year 2, although not statistically significant (Table 5). Numeric observations of both years suggest that the early-weaned and pre-weaned calves experienced the greatest amount of shrink compared to control and creep fed. This response is likely due a more advanced formation of the rumen once nursing ceases and forage intake increases. This greater rumen volume allows for a greater amount of rumen content to contribute toward the 24 hour shrink. In both years, calf ADG over the entire receiving period (29 days) was greater for early-weaned vs. control calves. Control calves had a numerically lesser ADG compared to all other treatments in both years (Table 5).

In the first week of the receiving phase, early-weaned calves consumed more grain and less hay compared to control calves (Table 6). Pre-weaned calves consumed more grain, but a similar amount of hay compared to creep-fed calves. This difference diminished by week 2 with no further differences observed over the next 3 weeks. Overall average dry matter intake was greatest for early-weaned compared to control and also greater for pre-weaned compared to creep-fed calves. Interestingly, these same contrasts did not hold true for the efficiency of feed converted to body weight gain (F:G) as early-weaned calves had an improved F:G compared to control, but the F:G of pre-weaned and creep-fed calves did not differ (Table 7). Creep-fed and pre-weaned calves together tended to have a better F:G compared to control (Table 7).

There was a significant year x treatment x day interaction for plasma concentrations of haptoglobin. In both years plasma haptoglobin concentrations peaked on day 1, which corresponded to the day calves arrived into the feedlot. However, differences among treatments were only observed in year 1. Similar to the results of the calves transported to North Carolina, early-weaned calves had a lesser peak in haptoglobin concentrations on day 1 (arrival into feed yard) compared to control calves (Figure 2). Plasma haptoglobin concentrations were less in creep-fed versus pre-weaned calves on day 0, prior to shipping, but increased sharply after shipping and were greater than pre-weaned on days 1 and 4 (Figure 2). Plasma ceruloplasmin concentrations following transportation and feedlot entry differed among years and within treatments (Figure 3). In both years, early-weaned calves had lesser plasma ceruloplasmin concentrations compared to control on day 0 prior to loading and transport. Following transport in both years 1, control calves experienced a sharp increase in ceruloplasmin concentrations. In year 1, ceruloplasmin concentrations in control calves were greater than early-weaned calves on d 15, 22, and 29 (Figure 3). Creep-fed calves also maintained greater ceruloplasmin concentrations than pre-weaned calves in both years, with significant differences observed on day 29 (year 1) and day 4 (year 2) (Figure 3).

Overview and Economic Considerations

The term "calf preconditioning" is overused and under-defined. Throughout the US and even within specific regions, the term "preconditioning" can mean something different to every producer. Fortunately, some market outlets are clearly defining preconditioning programs and offering sales opportunities for producers to target their calves and specific management investments to a group of buyers that are informed how the calves were preconditioned. Today, it is generally accepted that a pre-shipping calf vaccination program results in reduced morbidity and improved feedlot performance. In market outlets that define preconditioning programs, the premiums paid to vaccinated calves are typically sufficient to account for the costs of the management program at the ranch.

The results of the current studies outlined in this paper reveal some new information while strengthening some widely recognized management concepts. First, early calf weaning (70 to 90 days of age) appears to impact the ability for calves to better tolerate the stressors associated with transport and feed yard entry. This is recognized primarily through the substantial improvement in feed efficiency during the first 30 days after feedlot entry. Although this response is diminished during the subsequent growing and finishing phases, the dramatic advantage over receiving may impact overall efficiency of the entire finishing process. Our data suggest that this improvement in efficiency is a result of a lessened acute phase protein response to the stressors associated with weaning and transportation. One explanation relates to the partitioning of nutrients away from body weight gain toward the production of inflammatory products, such as acute phase proteins.

Creep-feeding and pre-weaning are two other common management strategies. In our study, the intake of creep feed was not substantial (7.2 and 3.9 lb/d for years 1 and 2, respectively). This is a primary problem experienced by many producers attempting to creep feed calves prior to weaning. There is some evidence that suggest that Brahman-influenced calves may voluntarily consume less free-choice creep feed than calves of British breeding influence. The costs associated with creep feeding are also an important consideration. In our two-year study, creep-feeding cost an average of $34 dollars per calf annually (average of 49 days of consuming 5.4 lb/day). Compared to control calves, the added gain resulting from creep feeding was only 0.17

lb/d, resulting in a F:G conversion of 32:1 and an average cost of gain of $4.16/lb. This is a very poor result and could potentially be lessened if the creep-feeding process had been extended beyond 60 days. Although numerically less each year, creep-fed calves had similar ADG and dry matter intake compared to pre-weaned calves.

Although few, if any, value added marketing programs target creep-feeding as a management prerequisite, a period of pre-weaning prior to shipping is a commonly prescribed procedure. Allegedly, pre-weaning prepares the calf for the stressors associated with transport and feedlot entry, therefore decreasing the stress-related incidences of morbidity. In our study, pre-weaned calves had a numerically greater ADG in year 1, but not year 2, compared to control calves. Indeed, inherent variation found among years and locations are a major factor impacting the value of preconditioning programs involving pre-weaning management (Pritchard and Mendez, 1990). This lack of regularity among performance responses is a major consideration when considering whether or not to pre-wean beef calves in Florida, especially south Florida. The majority of Florida calves are weaned during the months of July, August and September. These months are also some of the most extreme for environmental conditions such as excessive heat, rainfall, insect pressures, and violent storms. The risks associated with pre-weaning during these months must be weighed against any potential advantages associated with market premiums paid for the practice. In our study, the feed inputs associated with pre-weaning for approximately 48 days prior to shipping cost an average of $56 per calf. The added risk due to death loss and/or injury during this time adds another $10 to the variable costs of the practice. This total cost of $66 does not include labor and miscellaneous expenses such as fencing and feeding equipment. Our 600 lb steer calves would need to receive over $6 per cwt (1 cwt = 45.45 kg) premium just to offset the cost of feed. An analysis of the impact of certified health programs on the value of feeder calves was conducted on 268,500 calves in 2003 and 326,500 calves in 2005. A comparison of calves with similar vaccination management revealed an average premium of only $3.75 per cwt for calves that were pre-weaned for at least 45 days prior to shipping compared to calves shipped at the time of weaning (2003 data from Pfizer Animal Health, Technical Bulletin, SV-2004-02; 2005 data from King et al., 2006). This large-scale evaluation suggests that buyers are not willing to pay a premium for pre-weaned calves sufficient to offset the costs of feed. When considering the economic merits of pre-weaning, it is also important to factor in the risk of animal injury or death during the pre-weaning period. Typically, large Florida ranches are not designed to handle large groups of freshly weaned calves. Several complications can occur in the early days and weeks immediately following weaning. Some examples include, 1) leg and hoof injuries due to attempts to return to the dam, and 2) metabolic disorders from the consumption of grain supplements. Since these examples are not necessarily linked to pathogenesis, a good vaccination program may not prevent all production losses associated with pre-weaning management. At our facility, we average approximately 1.5 calves pulled from the truckload sale lot due to incidences directly related to the pre-weaning period (approximately 1.75 %).

Concluding Comments

A long-term aim of our research efforts, of which these studies are a part, is to attempt to assess the utility of using plasma acute-phase protein concentrations to predict post-weaning calf performance. Although there is evidence that acute-phase protein concentrations are elevated in morbid feedlot cattle (Berry et al., 2004; Carter et al., 2002), there has been little effort placed on linking acute-phase protein concentrations to the performance of apparently healthy calves. Some current and ongoing studies in our laboratory suggest that selected acute phase protein values can explain up to 40% of the variation in ADG of newly received feeder calves. Surprisingly, this correlation strengthens among the best performing calves. All of these data are collected and analyzed from overtly healthy calves. In the future, we may be able to use a panel of acute phase proteins to select and sort calves within individual management groups depending on their expectation for subsequent performance.

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Tables

Table 1. Effect of transportation on mean plasma acute phase protein concentrations in newly weaned calves, Year 1

	Treatment	
Item/d	Transported [a]	Non-transported
Fibrinogen, mg/100 mL		
Weaning	221 [b]	212 [c]
After transport	329 [c†]	141 [b†]
d 1	408 [d†]	212 [c†]
d 3	263 [b†]	331 [d†]
d 7	344 [c]	159 [bc]
Ceruloplasmin, mg/100 mL		
Weaning	29.8 [b]	28.1 [b]
After transport	28.4 [b]	28.1 [b]
d 1	27.8 [b]	27.9 [b]
d 3	28.7 [b]	29.3 [b]
d 7	40.7 [c†]	31.9 [c†]
Haptoglobin, mg HbB/100 mL [e]		
Weaning	1.72 [bc]	0.31 [b]
After transport	1.10 [bc]	0.29 [b]
d 1	0.93 [bc†]	2.45 [c†]
d 3	0.15 [b†]	2.40 [c†]
d 7	2.22 [c]	1.43 [bc]

[a] Transported calves were hauled for 3 hours.
[bcd]Means with unlike superscripts within item differ among sampling d, *P* < 0.05. Pooled SEM = 21.8, 0.80, and 0.59 for fibrinogen, ceruloplasmin, and haptoglobin, respectively. Sampling d x transportation interaction, P < 0.01 for each protein.
[†]Means within item and sampling d differ, P < 0.05.
[e]Amount of hemoglobin bound by haptoglobin per 100 mL of plasma.

Table 2. Mean plasma acute phase protein concentrations in newly weaned calves, Year 2

Item	Day of study [a]							
	Weaning	After-transport	5	9	13	17	21	Pooled SEM
	mg/100 mL							
Fibrinogen	177.9[b]	253.7[c]	260.1[c]	200.5[b]	271.3[c]	246.9[c]	184.0[b]	9.06
Ceruloplasmin	19.6[b]	24.4[c]	27.2[d]	28.3[d]	32.0[e]	32.9[e]	30.0[d]	0.78
α-acid glycoprotein	290.3[b]	-----	467.9[c]	-----	379.9[d]	-----	420.7[cd]	20.77
	mg HbB/100 mL[f]							
Haptoglobin	4.6[b]	5.4[b]	13.4[d]	5.8[b]	5.9[b]	9.3[c]	6.4[bc]	1.08

[a] Day of study relative to weaning.
[bcde] Means with unlike superscripts within item and across day of study differ, $P < 0.05$. Linear and Quadratic time contrasts = 0.63 and < 0.01 for fibrinogen, < 0.01 and < 0.01 for ceruloplasmin, < 0.01 and < 0.01 for α-acid glycoprotein, and 0.51 and 0.03 for haptoglobin.
[f]Amount of hemoglobin bound by haptoglobin per 100 mL of plasma.

Table 3. Effects of early- vs. normal weaning age on calf feedlot performance[a]

Item[b]	Early-weaned	Normal-weaned	SEM [c]	*P* =
Receiving				
Initial wt., kg [d]	221	269	10.6	0.03
ADG, kg/d	0.87	0.40	0.10	0.03
DMI, kg/d	5.65	5.27	0.28	0.36
G:F	0.157	0.081	0.010	0.01
Overall				
ADG, kg/d	1.23	1.25	0.11	0.82
Total BW gain, kg	295	267	9.3	0.10
Total DMI, kg	1919	1976	74.9	0.62
G:F	0.155	0.136	0.004	0.02

[a] Early-weaned calves were removed from their dams at 85 days of age. Normal-weaned calves remained with their dams until the day of normal weaning (average age = 300 days).
[b]Receiving diet = d 0 to 28; Growing diet = day 28 to 112; and Finishing diet = day 112 to 215 (slaughter date 1) or day 250 (slaughter date 2). Assignment to slaughter date was achieved by selecting 20 steers with the greatest 12[th] rib backfat thickness (determined by ultrasonography). Table values are least square means.
[c]Largest SEM of least square means (n = four pens/treatment).
[d]Initial BW determined on day 3 after feedlot entry once free-choice hay was removed.

Table 4. Effects of weaning management on pre-transport performance of beef calves (actual mean ± stnd. dev.)[a]

Item	Control [b]	Creep-fed [c]	Pre-weaned [d]
Year 1	----------------	kg	----------------
Initial BW	253 ± 27.2	244 ± 20.0	248 ± 24.9
Final BW	273 ± 24.0	273 ± 24.5	276 ± 27.6
ADG	0.54 ± 0.18	0.63 ± 0.34	0.70 ± 0.16
Year 1			
Initial BW	241 ± 54.0	258 ± 37.6	244 ± 24.9
Final BW	275 ± 63.0	295 ± 38.5	268 ± 22.2
ADG	0.66 ± 0.25	0.73 ± 0.15	0.46 ± 0.15

[a] Prior to transport all calves remained in a single group within treatment providing no replication within year; therefore, no statistical analysis of data was conducted prior to shipping. Average daily consumption of feed was 3.27 and 1.77 kg/day for creep-fed and 3.99 and 4.08 kg/day for pre-weaned calves in years 1 and 2, respectively. Data represent 45 and 52 days between initial and final for years 1 and 2, respectively.

[b] Control: Calves weaned from their dam on the day of transport.

[c] Creep fed: Calves provided free-choice access to creep feed prior to transport.

[d] Pre-weaned: Calves permanently separated from their dam prior to transport and provided free-choice access to feed while on pasture.

Table 5. Effects of beef calf weaning management on post-transport performance

Item	Control	Creep-fed	Early-weaned	Pre-weaned	Contrasts [a] 1	2	3	SEM
Year 1								
d 0, kg	276	275	259	278	< 0.01	0.30	0.85	1.7
d 1, kg	256	258	234	250	< 0.01	0.04	0.44	2.3
d 29, kg	291	295	283	291	0.11	0.44	0.50	2.9
Shrink, %	7.03	6.14	9.18	9.77	0.06	< 0.01	0.32	0.72
ADG, kg	0.86	1.08	1.44	1.20	< 0.01	0.50	0.07	0.11
Year 2								
d 0, kg	275	295	293	268	0.01	< 0.01	0.24	4.0
d 1, kg	250	269	266	243	0.02	0.01	0.25	3.9
d 29, kg	286	307	314	287	< 0.01	0.01	0.08	4.7
Shrink, %	9.18	8.92	9.33	9.23	0.73	0.47	0.78	0.29
ADG, kg	0.90	1.02	1.34	1.12	0.02	0.53	0.25	0.12

[a] Single degree-of-freedom orthogonal contrasts:
1 = Control vs. Early-weaned
2 = Creep-fed vs. Pre-weaned
3 = Control vs. Creep-fed and Pre-weaned

Table 6. Effects of beef calf weaning management on post-transport dry matter intake of hay and concentrate [a]

Item	Control	Creep-fed	Early-weaned	Pre-weaned	Contrasts [b] 1	2	3	SEM
Grain DMI, % BW								
Wk 1	1.30	1.62	2.17	2.24	< 0.01	< 0.01	< 0.01	0.11
Wk 2	2.04	2.13	2.31	2.51	0.12	0.03	0.06	0.11
Wk 3	2.28	2.26	2.40	2.38	0.41	0.41	0.79	0.10
Wk 4	2.23	2.19	2.35	2.48	0.41	0.07	0.42	0.10
Hay DMI, % BW								
Wk 1	0.66	0.42	0.42	0.38	< 0.01	0.59	< 0.01	0.04
Wk 2	0.57	0.47	0.45	0.43	0.10	0.57	0.07	0.05
Wk 3	0.47	0.45	0.47	0.48	0.92	0.48	0.94	0.03
Wk 4	0.46	0.46	0.48	0.48	0.78	0.78	0.89	0.05
Total DMI, % BW								
Wk 1	1.94	2.04	2.58	2.62	< 0.01	< 0.01	< 0.01	0.10
Wk 2	2.61	2.60	2.76	2.95	0.28	0.02	0.17	0.10
Wk 3	2.75	2.71	2.87	2.86	0.44	0.30	0.80	0.10
Wk 4	2.69	2.65	2.83	2.95	0.23	0.02	0.27	0.08

[a] Hay and concentrate were provided free choice in separate areas of the bunk and dry matter intake of each was recorded daily.

[b] Single degree-of-freedom orthogonal contrasts:
1 = Control vs. Early-weaned
2 = Creep-fed vs. Pre-weaned
3 = Control vs. Creep-fed and Pre-weaned

Table 7. Effects of beef calf weaning management on average total dry matter intake (DMI) and efficiency of feed conversion (F:G)

Item	Control	Creep-fed	Early-weaned	Pre-weaned	Contrasts [a] 1	2	3	SEM
Average DMI, % BW	2.50	2.50	2.76	2.84	0.01	< 0.01	0.04	0.06
F:G	8.36	7.44	6.03	7.17	< 0.01	0.68	0.08	0.45

[a] Single degree-of-freedom orthogonal contrasts:
1 = Control vs. Early-weaned
2 = Creep-fed vs. Pre-weaned
3 = Control vs. Creep-fed and Pre-weaned

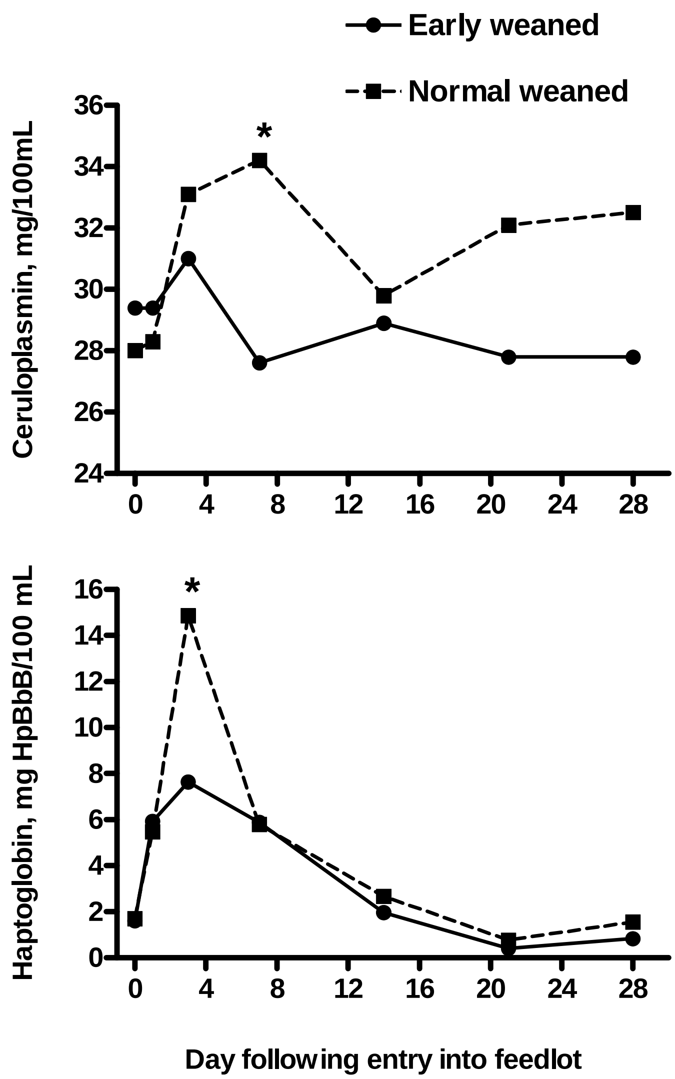

Figure 1. Effect of early calf weaning on plasma ceruloplasmin and haptoglobin concentrations upon entry into a feedyard. Early-weaned calves removed from their dams at 85 d of age. Normal-weaned calves remained with their dams until the day of normal weaning (average age = 300 days). Upon weaning calves were transported approximately 1200 km directly into a feedyard. Time x treatment; $P < 0.001$. Means differ on day 7 and d 3 for ceruloplasmin and haptoglobin, respectively; *= $P < 0.05$. Pooled SEM = 0.75 (n = four pens/treatment).

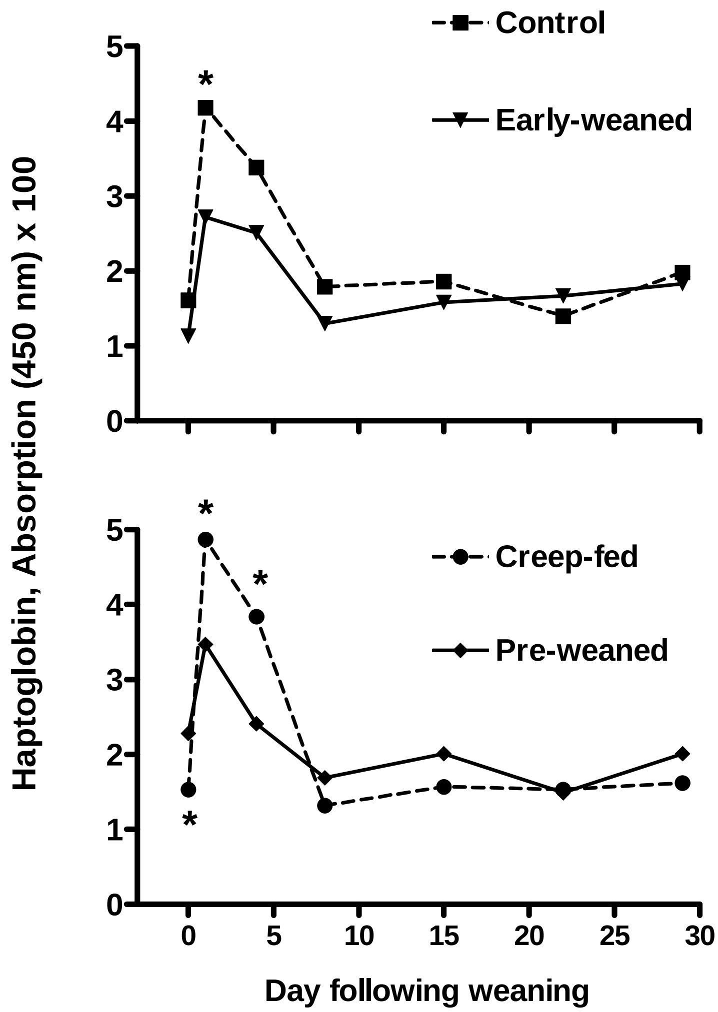

Figure 2. Effect of weaning management on plasma haptoglobin concentrations upon entry into the feedyard in year 1. Greatest pooled SEM = 0.19. Single degree-of-freedom contrasts differ ($P < 0.05$) as noted: 1 = Control vs. Early-weaned, and 2 = Creep-fed vs. Pre-weaned.

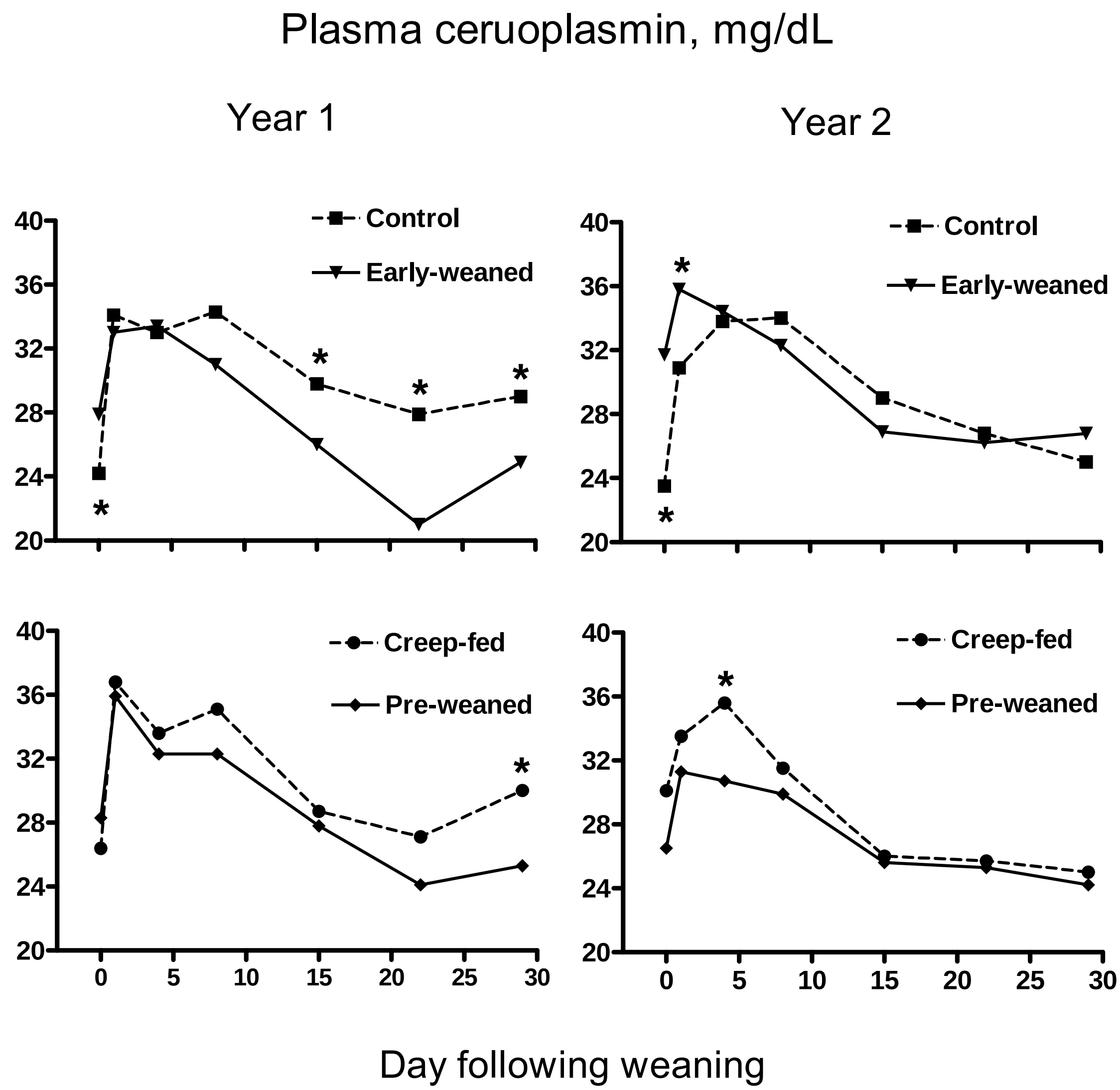

Figure 3. Effect of weaning management on plasma ceruloplasmin concentrations (mg/dL) upon entry into the feedyard in year 1 and 2. Greatest pooled SEM = 2.68. Single degree-of-freedom contrasts differ ($P < 0.05$) as noted: 1 = Control vs. Early-weaned, and 2 = Creep-fed vs. Pre-weaned.