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Beef Cattle Sciences

Oregon Beef Council Report

2011 Edition

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Oregon Beef Council Report

Thank you for the interest in the 2011 - Oregon Beef Council Report. This publication contains information about research studies funded by the Oregon Beef Council, and conducted by faculty members from Oregon State University. In this publication, all articles are printed in grayscale. Colored articles are available at the Beef Cattle Sciences website (http://beefcattle.ans.oregonstate.edu), under the "Extension Publications" link. For questions, suggestions, or comments regarding this publication, please contact Reinaldo Cooke (541-573-4083 or reinaldo.cooke@oregonstate.edu).

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Oregon Beef Council Report

Protein Supplementation of Low-Quality Forage: Effects of Amount and Frequency on Intake, Nutrient Digestibility, and Performance[1]

D. W. Bohnert[2], R. F. Cooke[3], S. J. Falck, B. I. Cappellozza, M. Van Emon, and C. S. Schauer

Synopsis

When providing supplemental CP to ruminants consuming low-quality forage at extended intervals, such as once every 10 days, it is possible for managers to maintain acceptable forage intake, digestibility of nutrients, and cow performance by reducing the amount, and cost, of supplement provided.

Summary

Three experiments were conducted to evaluate the effect of amount and frequency of crude protein (CP) supplementation on ruminants consuming low-quality forage. Treatments were arranged in a 2 × 3 factorial design (two levels of CP provided daily, once every 5 days, or once every 10 days) with an unsupplemented control. The greater level of CP was estimated to meet ruminal requirements for degradable intake protein and the lower level was 50% of the greater level. Soybean meal (SBM) was used as the CP supplement. Seven steers (661 ± 20 lb; Experiment 1) and 7 wethers (68 ± 1 lb; Experiment 2) were used in duplicate 4 × 7 incomplete Latin square designed experiments to determine the influence of treatments on nutrient intake and digestion. Experimental periods were 30 days with feed and digesta collected on d 19 through 28 and day 21 through 30, respectively, for estimation of nutrient digestibility.

Eighty-four cows (1,231 ± 9 lb; 4.8 ± 0.04 body condition score; BCS) in the last third of gestation were used in Experiment 3 to evaluate treatment effects on weight and body condition score (BCS) change. Treatments were evaluated using the following contrasts: 1) Control vs CP supplementation, 2) Full CP vs Half CP, 3) linear effect of supplementation frequency, 4) quadratic effect of supplementation frequency, 5) Interaction of linear effect of supplementation frequency and level of CP, and 6) Interaction of quadratic effect of supplementation frequency and level of CP.

Hay intake by steers increased ($P = 0.03$) with CP supplementation but only tended to increase ($P = 0.08$) with Full CP compared with Half CP. In contrast, hay and total intake by lambs was not affected ($P > 0.25$) by CP supplementation. Interestingly, a linear effect of CP amount × supplementation frequency interaction for both hay and total intake was noted for steers ($P = 0.02$) and a tendency was noted for lambs ($P < 0.09$), with intake decreasing a greater amount from daily to once every10 days with Full CP supplementation compared with little to no reduction with Half CP.

Diet digestibility by steers tended ($P = 0.10$) to be greater with CP supplementation and was increased ($P < 0.01$) by lambs. This, with the intake data, resulted in a greater quantity of nutrients available for utilization by the animal with CP supplementation.

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Associate Professor, Oregon State University - EOARC, Burns 97720. Email: dave.bohnert@oregonstate.edu
3. Assistant Professor, Oregon State University - EOARC, Burns 97720. Email: reinaldo.cooke@oregonstate.edu

Efficiency of CP utilization by lambs was greater with CP supplementation but was not altered by amount of supplement (P = 0.94) or supplementation frequency (P > 0.92). In addition, plasma urea was greater with CP supplementation (P < 0.01) and for Full CP compared with Half CP (P ≤ 0.02) in both steers and lambs.

Cow pre- and post-calving weight and BCS change was improved with CP supplementation (P ≤ 0.03). Likewise, pre- and post-calving weight change and pre-calving BCS change were improved (P ≤ 0.01) with Full CP compared with Half CP. However, the change in pre-calving weight and BCS was less as supplementation frequency decreased for Half CP compared with Full CP (P = 0.01).

These data suggest that reducing the amount of supplemental CP, when supplementation intervals are greater than 5 or 6 days, can be a management tool to maintain acceptable levels of intake, digestibility, and cow performance while reducing supplement cost.

Introduction

Production of beef cattle is consistently the number two agriculture commodity in Oregon. Consequently, raising cattle is the largest generator of livestock value in Oregon and is dominated by commercial cow/calf production with over 500,000 producing females located in the state. Most cattle spend their entire lives, except for the final 4 to 6 months in the feedlot, grazing standing forage or consuming hay. Forage quality is usually sufficient to support normal levels of production early in the growing season; however, as forages mature they increase in fiber content, decrease in CP, and decrease in digestibility. As a result, many cattle in Oregon and the western United States consume low-quality forage (< 6% CP) from late summer through winter and require some form of supplementation to maintain desired levels of performance.

Protein supplementation of low-quality forage has been shown to increase cow weight gain and BCS, forage intake and digestibility, and can improve reproductive performance. However, winter supplementation can be very expensive. Winter feed costs in the intermountain west often total $150 to 250 per cow per year. In addition to actual supplement costs, winter supplementation includes other expenses such as the labor, time, and equipment associated with supplement delivery. In contrast to other areas of North America, winter feed costs represent an economic disadvantage and could substantially threaten the economic future of the beef industry in this region.

Decreasing the frequency of protein supplementation is one management practice that can decrease labor and time costs by greater than 80% compared with daily supplementation. Ruminants have the ability to recycle excess absorbed nitrogen back to the rumen; therefore, recycling of absorbed nitrogen may support ruminal fermentation between times of supplementation. Consequently, research has shown that protein supplements can be fed at infrequent intervals and still maintain acceptable levels of performance (Hunt et al., 1989; Huston et al., 1999; Bohnert et al., 2002); however, data is limited comparing the effects of altering the amount of protein provided at infrequent intervals on forage intake and digestibility, animal performance, and efficiency of protein use.

It is possible that ruminants consuming low-quality forage may be able to adapt to infrequent supplementation of CP by increasing their ability to recycle nitrogen, thereby improving efficiency of CP use. We hypothesize that as the supplementation interval increases ruminants will become more efficient in their use of supplemental CP. As a result, we should be able to provide LESS total CP and maintain performance comparable to more frequent supplementation of MORE total CP. This will not only save time and labor, but will decrease the amount and cost of supplement provided to beef cows consuming low-quality forage, and therefore increase economic returns of Oregon's beef producers (Table 1).

Materials and Methods

Experiment 1. Seven ruminally cannulated Angus x Hereford steers (661 ± 22 lb) were used in a 4 × 7 incomplete Latin square design and housed in individual pens within an enclosed barn with continuous lighting. Steers were provided continuous access to fresh water and a low-quality cool season hay (Chewings fescue grass seed straw; 2.9% CP). A trace mineralized salt mix was provided daily. Treatments were arranged in a 2 × 3 factorial design with 2 levels of CP provided daily, once every 5 days, or once every 10 days with an unsupplemented control (daily, 5-day, and 10-day treatments, within CP level, received the same total amount of CP over a 10-day period). The greater level of CP was estimated to meet ruminal requirements for degradable intake protein and the lower level was 50% of the greater level. Soybean

meal (SBM; 51.4% CP) was placed directly into the rumen via the ruminal cannula for supplemented treatments.

Experimental periods were 30 d, with intake measured beginning d 19 and concluding d 28. On day 11 (day of supplementation for all treatments except for control) and day 20 (day before supplementation for all treatments except for control), treatment effects on ruminal indigestible fiber fill were determined by manually removing the contents from each steer's reticulo-rumen 4 h after feeding. Feces were collected on days 21 to 30.

On days 21 and 30, ruminal fluid was collected by suction strainer immediately prior to feeding and at 3, 6, 9, 12, 18, and 24 hours post-feeding. Ruminal fluid pH was measured immediately after collection.

Data were analyzed as an incomplete 7 × 4 Latin square. The model for intake and digestibility data included period and treatment. The model for samples collected at fixed times included period, treatment, time, and treatment × time. Contrast statements were: 1) Control vs CP supplementation, 2) Full vs Half CP, 3) linear effect of supplementation frequency, 4) quadratic effect of supplementation frequency, 5) Interaction of linear effect of supplementation frequency and level of CP, and 6) Interaction of quadratic effect of supplementation frequency and level of CP.

Experiment 2. Seven wethers (68 ± 1 lb) were used in a 4 × 7 incomplete Latin square design. Lambs were provided continuous access to fresh water and a low-quality cool season hay (Chewings fescue grass seed straw; 4.9% CP). A trace mineralized salt mix was provided daily. Treatments were arranged in a 2 × 3 factorial design (two levels of CP provided daily, once every 5 days, or once every 10 days) with an unsupplemented control. The greater level of CP was estimated to meet the CP requirement of a 66 lb lamb gaining 0.44 lb/day; the lower level was 50% of the greater level. Soybean meal (SBM; 49.9% CP) was used as the CP supplement and was offered to lambs immediately prior to hay feeding.

Experimental periods were 30 d, with intake measured beginning d 19 and concluding d 28. Feces and urine were collected on days 21 to 30. In addition, blood samples were collected on days 21 to 30 for analysis of plasma urea.

Data were analyzed as an incomplete 7 × 4 Latin square. The model for intake and digestibility data included period and treatment. The model for plasma urea included period, treatment, day, and treatment × day. The same contrasts described in Experiment 1 were used to evaluate treatment effects.

Experiment 3. Eighty-four cows (1231 ± 9 lb; 4.8 ± 0.04 BCS) in the last third of gestation were stratified by age, body condition score, and weight and assigned randomly within stratification to the treatments described in Experiment 1 using a Randomized Complete Block design. Soybean meal was used as the source of supplemental CP (51.7% CP). The cows were then sorted by treatment and allotted randomly to 1 of 21 pens. The greater level of CP was, on a daily basis, 0.525 lb CP/hd and the lower level was 50% of the greater level. Supplements were provided through calving. Cows had continuous access to water, salt, and a vitamin/mineral mix. They were offered ad libitum access to low-quality grass seed straw (2.4% CP) at 0800 daily.

Cow weight and BCS were measured every 14 days until calving and within 24 hours after calving. In addition, calf weights were obtained within 24 hours of birth.

Data were analyzed as a Randomized Complete Block. The model included block, treatment, and Block × treatment. The same contrasts described in Experiment 1 were used to evaluate treatment effects.

Results

Experiment 1. Hay ($P = 0.03$) and total ($P < 0.01$) intake increased with CP supplementation; however, we noted a linear effect of CP amount × supplementation frequency interaction ($P = 0.02$) for both hay and total intake, with intake decreasing almost 17% from daily to once every10 days with Full CP supplementation compared with essentially no reduction with Half CP (Table 2). Digestibility was not altered by CP supplementation ($P = 0.10$) but it increased quadratically ($P < 0.01$) as the supplementation interval increased. Fiber digestibility (neutral detergent fiber) was not affected by treatments ($P > 0.12$).

Ruminal particulate fill was not affected by treatments on the day all supplements were provided ($P > 0.31$; Table 3); however, when only daily supplements were provided, ruminal particulate fill was greater ($P = 0.03$) with CP supplementation. Also, ruminal particulate passage rate was increased with CP supplementation ($P > 0.03$).

A day × treatment interaction ($P < 0.01$) was noted for plasma urea (Figure 1); however, after

evaluating the nature of the responses we decided to provide the day × treatment figure and discuss overall treatment means. Plasma urea increased with CP supplementation ($P < 0.01$; Table 2) and was greater with Full CP compared with Half CP ($P < 0.01$).

Ruminal pH decreased linearly as supplementation frequency decreased ($P < 0.01$) when all supplements were provided; however no affect was noted when only daily supplements were provided ($P > 0.22$).

A time × treatment interaction ($P < 0.01$) was noted for ruminal ammonia when all supplements were provided (Figure 2); however, after evaluating the nature of the responses we decided to provide the time × treatment figure and discuss overall treatment means. Ruminal ammonia increased with CP supplementation when all supplements were provided and was greater with Full CP compared with Half CP ($P < 0.01$). However, a linear effect of CP amount × supplementation frequency interaction ($P = 0.02$) was observed with ruminal ammonia increasing 400% from daily to once every10 days with Full CP supplementation compared with approximately 300% with Half CP (Table 3; Figure 2). When only daily supplements were provided, we noted no CP supplementation effect ($P = .44$) or difference between Full CP and Half CP ($P = .64$); nevertheless, ruminal ammonia decreased as supplementation frequency decreased ($P < 0.01$).

Experiment 2. Hay and total intake were not affected ($P > 0.25$) by CP supplementation. However, similar to Experiment 1, a tendency for a linear effect of CP amount × supplementation frequency interaction ($P \leq 0.09$) was noted for both hay and total intake, with intake decreasing over 30% from daily to once every10 days with Full CP supplementation compared with less than 10% with Half CP (Table 4).

Digestibility was increased 19% with CP supplementation ($P < 0.01$) and also increased ($P = 0.04$) as the supplementation interval increased. No difference in digestibility was noted between Full CP and Half CP ($P = 0.28$). As with intake, fiber digestibility (neutral detergent fiber) was increased ($P = 0.02$) almost 10% with CP supplementation. Also, fiber digestibility increased 11% as supplementation frequency decreased from daily to once every 10 days with Full CP compared with a 3% decrease with Half CP ($P = 0.04$).

Crude protein intake increased with CP supplementation ($P < 0.01$), for Full CP compared with Half CP ($P < 0.01$), and decreased as supplementation interval increased ($P = 0.04$). Digestibility of CP was increased greater than 300% with CP supplementation ($P < 0.01$), 21% greater for Full CP compared with Half CP ($P < 0.01$), and decreased as supplementation interval increased ($P = 0.01$).

The efficiency of CP use, measured as the quantity of digested CP retained in the body, was increased with CP supplementation ($P < 0.01$) but was not affected by amount of supplemental CP ($P = 0.94$) or supplementation frequency ($P > 0.92$) (Table 4).

As with Experiment 1, a day × treatment interaction ($P < 0.01$) was noted for plasma urea (Figure 3); however, after evaluating the nature of the responses we decided to provide the day × treatment figure and discuss overall treatment means. Plasma urea increased with CP supplementation ($P < 0.01$; Table 4) and was greater with Full CP compared with Half CP ($P = 0.03$).

Experiment 3. Pre- and Post-calving weight change by cows was improved with CP supplementation ($P < 0.03$) and for Full CP compared with Half CP ($P < 0.02$; Table 5). However, both pre- and post-calving weight change were negatively affected as supplementation frequency decreased ($P < 0.01$). It is of interest to note that there was less pre-calving weight change as supplementation frequency decreased from daily to once every 10 days for Half CP compared with Full CP ($P = 0.01$). Calf birth weight was not affected by treatment ($P > 0.19$).

Similar to our observations with cow body weight, pre- and post-calving change in BCS was improved with CP supplementation ($P < 0.03$). Also, pre-calving BCS change was improved with Full CP compared with Half CP ($P < 0.01$; Table 5) but negatively affected as supplementation frequency decreased ($P = 0.02$). Also, as with cow weight change, there was less pre-calving BCS change as supplementation frequency decreased for Half CP compared with Full CP ($P = 0.05$).

Conclusions

Reducing the amount of supplemental CP provided to ruminants consuming low-quality forages, when supplementation intervals are greater than 5 or 6 days, can be a management tool to maintain acceptable levels of intake, digestibility, and cow performance while reducing supplement cost.

Acknowledgements

This research study was funded by the Oregon Beef Council and the Agricultural Research Foundation. We would like to thank Lynn Carlon, Tony Runnels, Aaron Kennedy, Skip Nyman, Maria Reis, Felipe Sanches, and Flavia Cooke for their assistance in this study.

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Figure 1. Effect of protein amount and supplementation frequency on plasma urea nitrogen in steers. Columns from left to right for each treatment represent day 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 of a 10-day supplementation period, respectively. Treatments were: Control; D = 0.133% of body weight/day of soybean meal (SBM); 5D = 0.665% of body weight of SBM once every 5 days; 10D = 1.33% of body weight of SBM once every 10 days; 50% D = 50% of the D treatment; 50% 5D = 50% of the 5D treatment; 50% 10D = 50% of the 10D treatment. Each column with an S below it represents a supplementation day.

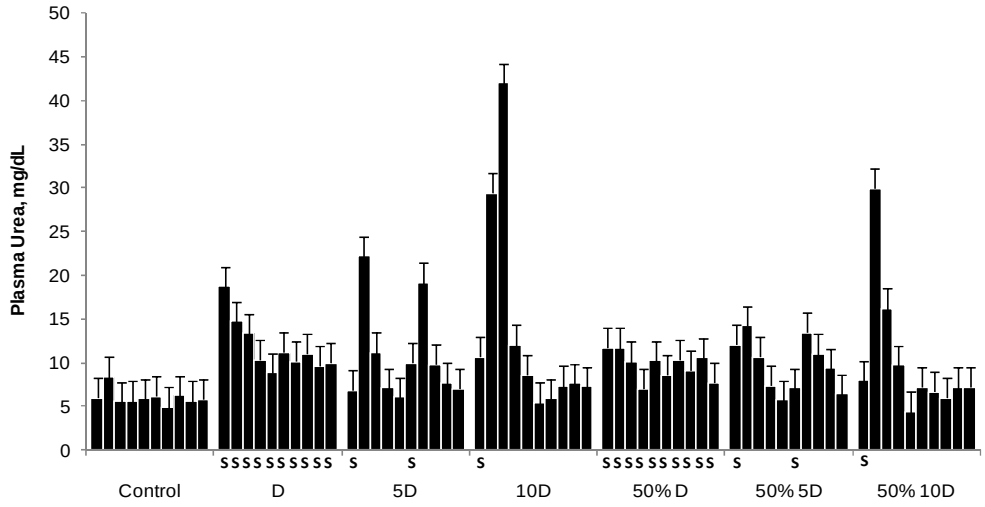

Figure 2. Effect of protein amount and supplementation frequency on steer ruminal ammonia N the day all supplements were provided. Columns from left to right for each treatment represent 0, 3, 6, 9, 12, 18, and 24 hours post-feeding, respectively. Treatments were: Control; D = 0.133% of body weight/day of soybean meal (SBM); 5D = 0.665% of body weight of SBM once every 5 days; 10D = 1.33% of body weight of SBM once every 10 days; 50% D = 50% of the D treatment; 50% 5D = 50% of the 5D treatment; 50% 10D = 50% of the 10D treatment.

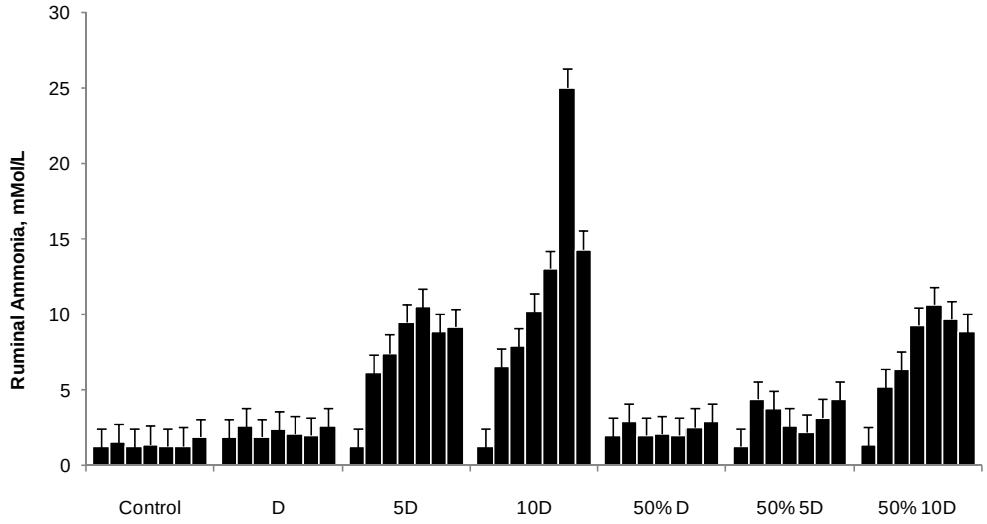

Figure 3. Effect of protein amount and supplementation frequency on plasma urea nitrogen in lambs. Columns from left to right for each treatment represent day 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 of a 10-day supplementation period, respectively. Treatments were: Control; D = 0.133% of body weight/day of soybean meal (SBM); 5D = 0.665% of body weight of SBM once every 5 days; 10D = 1.33% of body weight of SBM once every 10 days; 50% D = 50% of the D treatment; 50% 5D = 50% of the 5D treatment; 50% 10D = 50% of the 10D treatment. Each column with an S below it represents a supplementation day.

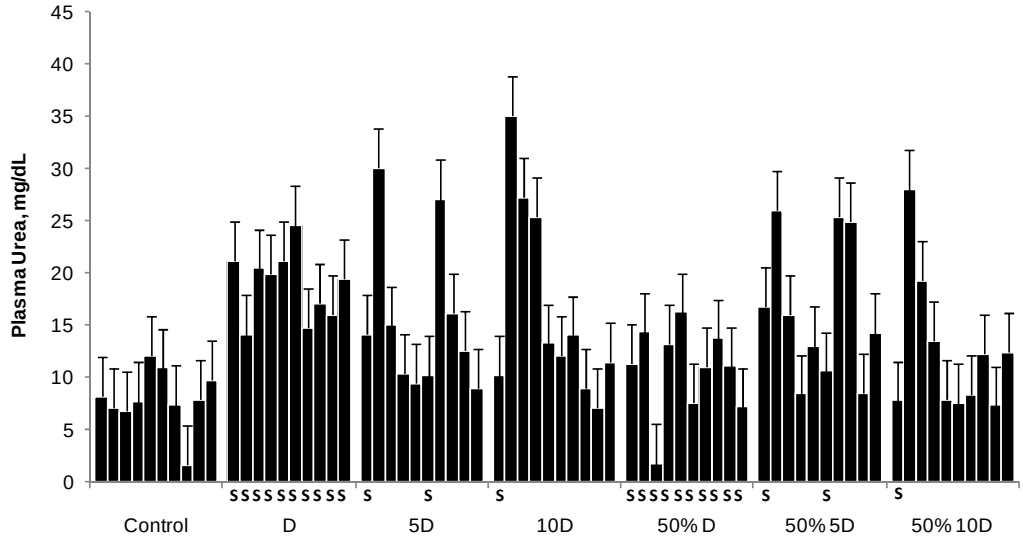

Table 1. Estimated cost of treatments over a 30-day Period. One pound of soybean meal (SBM), daily, was used as the basis to compare all other treatments.

	1 pound of Soybean Meal/head			1/2 pound of Soybean Meal/head		
	Daily	5 Days	10 Days	Daily	5 Days	10 Days
Fuel Cost ($)[a]	360.00	72.00	36.00	360.00	72.00	36.00
Labor Cost($)[b]	630.00	126.00	63.00	630.00	126.00	63.00
Supplement Cost ($)[c]	1,485.00	1,485.00	1,485.00	742.50	742.50	742.50
Total Cost ($)	2,475.00	1,683.00	1,584.00	1732.50	940.50	841.50
Labor/Fuel Cost Reduction	0	80%	90%	0	80%	90%
Supplement Cost Reduction	0	0	0	50%	50%	50%
Total Cost Reduction	0	32%	36%	30%	62%	66%
Total Benefit ($)	0	792.00	891.00	742.50	1,534.50	1633.50

[a] Fuel costs calculated as 3 gallons/supplementation day at $4.00/gallon
[b] Labor calculated as 2.5 hours/supplementation day at $8.40/hour
[c] Assuming 300 cow herd; cost of $330/ton

Table 2. Effect of CP amount (soybean meal; SBM) and supplementation frequency on intake, diet digestibility, and plasma urea in steers

	Treatment[a]								P-Value[c]					
	Con	D	5D	10D	50% D	50% 5D	50% 10D	SEM[b]	Con vs Supp	Full vs Half	L Freq	Q Freq	L Freq vs Amt	Q Freq vs Amt
Hay intake, % body weight	1.61	1.96	1.92	1.62	1.76	1.70	1.75	0.075	0.03	0.08	0.02	0.52	0.02	0.14
SBM intake, % body weight	0.000	0.133	0.133	0.133	0.067	0.067	0.067							
Total Intake, % body weight	1.61	2.10	2.05	1.76	1.83	1.77	1.81	0.075	< 0.01	< 0.01	0.02	0.52	0.02	0.14
Diet Digestibility, %	45.0	45.8	44.7	48.6	45.7	45.1	47.3	0.86	0.10	0.57	< 0.01	< 0.01	0.39	0.34
NDF Digestibility, %	48.2	47.5	46.2	49.0	47.8	47.4	48.5	1.03	0.64	0.68	0.26	0.12	0.69	0.48
Plasma Urea, mg/dL	6.0	11.8	10.7	13.6	9.7	9.7	10.2	0.72	<0.01	<0.01	0.10	0.07	0.38	0.16

[a] CON = control; D = 0.133 % body weight/day of SBM; 5D = 0.665% body weight of SBM once every 5 days; 10D = 1.33% body weight of SBM once every 10 days; 50% D = 50% of the D treatment; 50% 5D = 50% of the 5D treatment; 50% 10D = 50% of the 10D treatment.
[b] n = 4.
[c] Con vs Supp = control vs supplemented treatments; Full vs Half = full vs half amount of CP; L Freq = linear effect of supplementation frequency; Q SF = quadratic effect of supplementation frequency; L Freq vs Amt = interaction of the linear effect of supplementation frequency and amount of CP; Q Freq vs Amt = interaction of the quadratic effect of supplementation frequency and amount of CP.

Table 3. Ruminal particulate fill and ammonia concentration on the day of supplementation for all supplemented treatments and, other than daily treatments, the day before supplementation in steers

	Treatment[a]								P-value[c]					
	Con	D	5D	10D	50% D	50% 5D	50% 10D	SEM[b]	Con vs Supp	Full vs Half	L Freq	Q Freq	L Freq vs Amt	Q Freq vs Amt
Day of Supplementation	1.61	1.96	1.92	1.62	1.76	1.70	1.75	0.075	0.03	0.08	0.02	0.52	0.02	0.14
Particulate Fill, % BW	0.90	1.02	1.07	0.99	0.95	0.89	0.89	0.04	0.20	< 0.01	0.30	0.63	0.77	0.25
Particulate Passage rate, %/h	1.92	2.03	1.97	1.87	2.02	2.18	1.99	0.126	0.50	0.31	0.44	0.38	0.58	0.48
pH	6.7	6.7	6.6	6.4	6.9	6.6	6.6	0.09	0.33	0.07	0.01	0.66	0.90	0.22
Ammonia, mMol/L	1.4	2.2	7.6	11.2	2.4	3.1	7.4	0.78	<0.01	<0.01	<0.01	0.52	0.02	0.07
Day Before Supplementation														
Particulate Fill, % BW	0.97	1.09	1.01	1.02	0.95	0.91	0.90	0.06	0.85	0.02	0.34	0.55	0.88	0.75
Particulate Passage rate, %/h	1.54	1.92	2.01	1.77	1.86	1.91	1.97	0.144	0.03	0.90	0.92	0.52	0.38	0.52
pH	6.7	6.7	6.9	6.8	6.8	6.8	6.9	0.06	0.25	0.54	0.23	0.51	0.79	0.25
Ammonia, mMol/L	1.1	2.0	1.2	0.8	1.5	1.2	1.1	0.24	0.44	0.64	<0.01	0.38	0.10	0.81

[a] CON = control; D = 0.133 % body weight/day of soybean meal (SBM); 5D = 0.665% of body weight of SBM once every 5 days; 10D = 1.33% of body weight of SBM once every 10 days; 50% D = 50% of the D treatment; 50% 5D = 50% of the 5D treatment; 50% 10D = 50% of the 10D treatment.
[b] n = 4.
[c] Con vs Supp = control vs supplemented treatments; Full vs Half = full vs half amount of CP; L Freq = linear effect of supplementation frequency; Q SF = quadratic effect of supplementation frequency; L Freq vs Amt = interaction of the linear effect of supplementation frequency and amount of CP; Q Freq vs Amt = interaction of the quadratic effect of supplementation frequency and amount of CP.

Table 4. Effect of CP amount (soybean meal; SBM) and supplementation frequency on intake and diet digestibility by lambs

	Treatment[a]								P-Value[c]					
	Con	D	5D	10D	50% D	50% 5D	50% 10D	SEM[b]	Con vs Supp	Full vs Half	L Freq	Q Freq	L Freq vs Amt	Q Freq vs Amt
Hay intake, % body weight	1.88	2.16	1.95	1.40	2.02	1.93	1.87	0.173	0.97	0.45	0.02	0.60	0.08	0.52
SBM intake, % body weight	0.000	0.280	0.280	0.280	0.140	0.140	0.140							
Total Intake, % body weight	1.88	2.44	2.23	1.68	2.16	2.07	2.01	0.173	0.26	0.80	0.02	0.60	0.09	0.54
Diet Digestibility, %	37.4	40.6	45.7	49.6	43.5	43.5	43.5	1.98	<0.01	0.28	0.04	0.86	0.04	0.87
NDF Digestibility, %	42.2	43.6	46.9	48.6	46.0	45.7	44.7	1.39	0.02	0.43	0.19	0.64	0.04	0.86
CP Intake, % body weight	0.092	0.240	0.230	0.205	0.165	0.165	0.160	0.0092	<0.01	<0.01	0.04	0.54	0.12	0.75
CP Digestibility, %	12.2	49.5	58.4	65.8	45.5	48.9	48.4	3.40	<0.01	<0.01	0.01	0.67	0.07	0.85
Efficiency of CP Use, %[d]	-461	22	18	4	12	2	7	120	<0.01	0.94	0.92	0.99	0.96	0.95
Plasma Urea, mg/dL	9.0	18.9	15.4	16.5	11.7	16.4	12.4	1.73	<0.01	0.03	0.63	0.51	0.39	0.04

[a] CON = control; D = 0.280% of body weight/day of SBM; 5D = 1.4% of body weight of SBM once every 5 days; 10D = 2.8% of body weight of SBM once every 10 days; 50% D = 50% of the D treatment; 50% 5D = 50% of the 5D treatment; 50% 10D = 50% of the 10D treatment.
[b] n = 4.
[c] Con vs Supp = control vs supplemented treatments; Full vs Half = full vs half amount of CP; L Freq = linear effect of supplementation frequency; Q SF = quadratic effect of supplementation frequency; L Freq vs Amt = interaction of the linear effect of supplementation frequency and amount of CP; Q Freq vs Amt = interaction of the quadratic effect of supplementation frequency and amount of CP.
[d] Measured as the quantity of digested CP retained in the body.

Table 5. Effect of CP amount (soybean meal; SBM) and supplementation frequency on performance of cows in the last third of gestation

	Treatment[a]								P-Value[c]					
	Con	D	5D	10D	50% D	50% 5D	50% 10D	SEM[b]	Con vs Supp	Full vs Half	L Freq	Q Freq	L Freq vs Amt	Q Freq vs Amt
Body Weight														
Initial, lb	1240	1241	1217	1231	1175	1260	1250	24.5	0.66	0.93	0.17	0.47	0.08	0.10
Pre-Calving[d], lb	1216	1311	1270	1227	1199	1265	1264	28.3	0.16	0.22	0.73	0.45	< 0.01	0.47
Post-Calving[e], lb	1085	1179	1113	1115	1080	1123	1106	23.9	0.17	0.09	0.44	0.91	0.07	0.12
Pre-Calving Change, lb	-23	70	53	-4	24	6	15	12.7	<.001	0.01	< 0.01	0.76	0.01	0.11
Post-Calving Change, lb	-155	-62	-104	-116	-95	-137	-143	15.1	< 0.01	< 0.01	<.001	0.18	0.87	0.90
BCS														
Initial	4.8	4.8	4.8	4.8	4.8	4.8	4.9	0.07	0.49	0.66	0.73	0.51	0.76	0.47
Pre-Calving	4.4	4.9	4.8	4.6	4.6	4.6	4.6	0.10	0.02	0.05	0.08	0.97	0.06	0.51
Post-Calving BCS	4.1	4.6	4.6	4.4	4.5	4.4	4.4	0.09	<.001	0.34	0.14	0.61	0.21	0.51
Pre-Calving BCS	-0.4	0.1	0.0	-0.3	-0.2	-0.2	-0.3	0.09	0.027	< 0.01	0.02	0.53	0.05	0.90
Post-Calving BCS	-0.6	-0.2	-0.3	-0.5	-0.4	-0.4	-0.5	0.11	0.009	0.26	0.13	0.38	0.40	0.96

[a] CON = control; D = 1.02 lb/head of SBM daily; 5D = 5.1 lb/head of SBM once every 5 days; 10D = 10.2 lb/head of SBM once every 10 days; 50% D = 50% of the D treatment; 50% 5D = 50% of the 5D treatment; 50% 10D = 50% of the 10D treatment.
[b] n = 4.
[c] Con vs Supp = control vs supplemented treatments; Full vs Half = full vs half amount of CP; L Freq = linear effect of supplementation frequency; Q SF = quadratic effect of supplementation frequency; L Freq vs Amt = interaction of the linear effect of supplementation frequency and amount of CP; Q Freq vs Amt = interaction of the quadratic effect of supplementation frequency and amount of CP.
[d] Measured within 14 days prior to calving.
[e] Measured within 24 hours after calving.

Oregon State University

BEEF075

Beef Cattle Sciences

Oregon Beef Council Report

Camelina Meal Supplementation to Beef Cattle: I. Effects on Performance, DMI and Acute-Phase Protein Response of Feeder Steers Following Transport [1]

B. I. Cappellozza[2], R. F. Cooke[2], C. Trevisanuto[2], V. D. Tabacow[2], D. W. Bohnert[2] J. Dailey[3] and J. A. Carroll[3]

Synopsis

Camelina meal supplementation reduces stress-stimulated inflammatory reactions and enhances feedlot performance of feeder steers when supplemented during preconditioning.

Summary

Sixty Angus x Hereford steers were ranked by BW on d -28 of the study and allocated to 20 drylot pens, which were randomly assigned to receive: 1) supplement containing (as-fed basis) 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO) offered during preconditioning (PC; d -28 to 0) and feedlot receiving (FR; d 1 to 29), 2) supplement containing (as-fed basis) 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM) offered during PC and FR, 3) CAM offered during PC and CO offered during FR, 4) CO offered during PC and CAM offered during FR. Treatments were offered daily at a rate of 2.20 and 2.04 kg of DM/steer for CO and CAM, respectively. Alfalfa-grass hay was offered ad libitum during the study. On d 0, steers were loaded into a commercial livestock trailer, transported for 24 h, and returned to the research facility (d 1). Total DMI was evaluated daily, and shrunk BW was collected on d -31, 1, and 30 for ADG calculation. Blood samples were collected on d 0 (prior to loading), 1 (immediately upon arrival), 4, 7, 10, 14, 21, and 29 for determination of plasma cortisol and haptoglobin. Rectal temperatures were recorded concurrently with blood sampling on d 0, 1, 4, and 7. During PC, CAM steers tended to have reduced (P = 0.10) ADG compared to CO (0.26 vs. 0.37 kg/d, respectively). No treatment effects were detected (P > 0.16) for ADG during FR and total ADG. Steers receiving CAM during PC had reduced total DMI during PC and FR compared to CO cohorts (3.07 vs. 3.35 % of BW during PC, and 3.20 vs. 3.35 % of BW during FR, respectively). Steers receiving CAM during PC had reduced mean haptoglobin concentrations vs. CO cohorts on d 0 and 1 (1.64 vs. 1.79 absorbance at 450 nm × 100, respectively). Steers receiving CAM during FR had reduced (P = 0.02) mean haptoglobin and rectal temperatures during FR compared to CO cohorts (1.69 vs. 2.02 absorbance @ 450 nm × 100 of haptoglobin, and 39.05 vs. 39.14 ºC for temperature, respectively). In conclusion, camelina meal supplementation alleviated the acute-phase protein response stimulated by transport, but did not benefit performance of feeder steers.

Introduction

Three of the most stressful events encountered by a feeder calf are weaning, transportation, and feedlot entry. These events, which may occur together or in a short period of

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Oregon State University - Eastern Oregon Agricultural Research Center, Burns, OR.
3. Livestock Issues Research Unit, Agricultural Research Service – USDA, Lubbock, TX

time, lead to physiological, nutritional, and immunological changes that highly affect subsequent calf health and feedlot performance (Loerch and Fluharty, 1999). One example is the acute-phase response, an important component of the innate immune system that can be detrimental to growth rates in cattle (Qiu et al., 2007). Consequently, management strategies that prevent and/or alleviate the acute-phase response have been shown to benefit cattle productivity and overall efficiency of beef operations (Arthington et al., 2008).

Supplementation of a commercial source of polyunsaturated fatty acids (PUFA) to feeder calves prior to (Cooke et al. 2010) and after transportation (Araujo et al., 2010) reduced the acute-phase response during the initial days following transport, and benefited feedlot performance and carcass parameters (Cooke et al., 2010). Camelina meal, a byproduct from the mechanical processing of the camelina seeds for oil extraction, may contain up to 20% oil with the majority of the fatty acid content as PUFA (Moriel et al., 2010). Therefore, we theorized that camelina meal also serves as a sustainable nutritional alternative to modulate the acute-phase response in cattle subjected to stress of management. Based on this rationale, the objectives of the present study were to evaluate performance, physiological, and health parameters of feeder steers supplemented with camelina meal prior to and/or after transport to the feedyard.

Materials and Methods

This experiment was conducted in accordance with an approved Oregon State University Animal Care and Use protocol, and was divided into a preconditioning (PC; d -28 to 0) and a feedlot receiving phase (FR; d 1 to 29). Both phases were conducted at the Eastern Oregon Agricultural Research Center, Burns. Sixty Angus x Hereford steers weaned at 7 mo of age (d -55) were ranked by initial BW (221 ± 28.51 kg) on d -28 of the study, and randomly allocated to 20 dry lot pens (3 steers/pen). Pens were assigned to 1 of 4 treatments (5 pens/treatment): 1) supplement containing (as-fed basis) 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO) offered during PC (d -28 to 0) and FR (d 1 to 29), 2) supplement containing (as-fed basis) 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM) offered during PC and FR, 3) CAM offered during PC and CO offered during FR, 4) CO offered during PC and CAM offered during FR. Supplements were offered once a day (0700 h) at a rate of 2.20 and 2.04 kg of DM/steer for CO and CAM, respectively. Composition and nutritional profile of the supplements are described in Table 1. Supplement intakes were formulated to be iso-caloric and iso-nitrogenous, whereas mixed alfalfa-grass hay was offered in amounts to ensure ad libitum access throughout the experiment. On the morning of d 0, steers were loaded into a commercial livestock trailer, transported for 24 h, and returned to the research facility (d 1). Total and forage DMI were evaluated daily (d -28 to 28), and shrunk BW was assessed on d -31, 1, and 30 for ADG calculation.

Table 1. Composition and nutrient profile of supplements offered during the study.

Item	CO	CAM
Ingredient, DM basis		
Corn, kg	1.82	1.39
Soybean Meal, kg	0.32	--
Camelina, kg	--	0.59
Mineral Salt, kg	0.06	0.06
Nutrient profile, DM basis		
DM, %	87.0	88
TDN, %	94	95
CP, %	14.7	15.6
NDF, %	9.6	14.7
Ether extract, %	4.5	9.8
Ca, %	0.1	0.3
P, %	0.4	0.5

Blood samples were collected on d 0 (prior to loading), 1 (immediately upon arrival), 4, 7, 10, 14, 21, and 29, via jugular venipuncture into commercial blood collection tubes (Vacutainer, 10 mL; Becton Dickinson, Franklin Lakes, NJ) containing sodium heparin. Steer rectal temperature (RT) was measured at 30-min intervals with an automatic RT recording device during transport (Reuter et al., 2010), whereas on d 4 and 7 RT was measured with a digital thermometer (GLA M750 digital thermometer; GLA Agricultural Electronics, San Luis Obispo, CA) concurrently with each blood collection. All blood samples were harvested for plasma and stored at −80°C until assayed for concentrations of cortisol (Endocrine Technologies Inc., Newark, CA), and haptoglobin (Makimura and Suzuki, 1982). Performance and physiological data were analyzed using the PROC MIXED procedure of SAS (SAS Inst., Inc., Cary, NC) and Satterthwaite approximation to determine the denominator df for

the tests of fixed effects. The model statement used for PC performance contained the effects of PC treatment. Data were analyzed using pen(PC treatment) as the random variable. The model statement for FR performance contained the effects of PC treatment, FR treatment, and the resultant interaction. Data were analyzed using pen(PC × FR treatment) as the random variable. The model statement used for RT, cortisol, and haptoglobin data obtained on d 0 and 1 relative to transport contained the effects of PC treatment, day, and the resultant interaction because steers were assigned to their FR treatment after blood sampling on d 1. Data were analyzed using pen(PC treatment) as the random variable. Accordingly, the model statement used for RT, cortisol, and haptoglobin data obtained from d 4 to d 29 contained the effects of PC treatment, FR treatment, day, and all the resultant interactions. Data were analyzed using pen(PC × FR treatment) as the random variable. Results are reported as least square means and separated using LSD or PDIFF. Significance was set at $P \leq 0.05$. Results are reported according to treatment effects if no interactions were significant, or according to the highest-order interaction detected.

Results

During the PC phase (Table 2), CAM steers had reduced (P < 0.01) forage and total DMI compared to CO cohorts. Accordingly, CAM steers tended (P = 0.10) to have reduced ADG during PC compared to CO cohorts. However, no treatment effects (P = 0.24) were detected on preconditioning G:F. These findings support previous studies from our research group indicating that PUFA supplementation reduced DMI in cattle, but did not impair feed efficiency parameters (Araujo et al., 2010; Cooke et al., 2010).

Table 2. Preconditioning performance of beef steers supplemented (CAM) or not (CO) with camelina meal.

Item	CAM	CO	SEM	*P* =
Forage DMI, % of BW	2.23	2.46	0.04	< 0.01
Total DMI, % of BW	3.07	3.35	0.04	< 0.01
ADG, [1] kg/d	0.26	0.37	0.04	0.10
G:F, [2] kg/kg	0.038	0.049	0.006	0.24

[1]Calculated using shrunk values obtained on d-31 and d1.
[2]Calculating using total DMI and BW gain from d-28 to d1.

During the FR phase (Table 3), steers that received CAM during PC had reduced (PC treatment effect; P < 0.01) forage and total DMI compared to steers that received CO during the same period (2.46 vs. 2.61 % of BW for forage DMI, and 3.20 vs. 3.35 % of BW for total DMI, respectively; SEM = 0.03). Feed intake during FR was not affected by FR treatment or the PC × FR treatment interaction (P > 0.20). Moreover, ADG during FR was also not affected by PC treatment, FR treatment, or the PC × FR treatment interaction (P > 0.21). However, steers that received CAM during PC tended (PC treatment effect; P = 0.10) to have improved G:F during the FR compared to steers that received CO during the same period (0.231 vs. 0.215 kg/kg of G:F, respectively; SEM = 0.006). No FR treatment or PC × FR treatment interaction were detected for G:F during the FR phase.

Regarding RT and blood samples collected on d 0 and 1, no PC treatment effects were detected (P > 0.56) for plasma cortisol concentrations (41.8 vs. 39.4 ng/mL for CAM and CO steers, respectively; SEM = 5.2) or RT (39.19 vs. 39.16 ºC for CAM and CO steers, respectively; SEM = 0.03). However, CAM steers had reduced (P = 0.04) haptoglobin concentrations compared to CO cohorts (1.65 vs. 1.80 absorbance at 450 nm x 100, respectively; SEM = 0.05). Regarding RT and blood samples collected after d 4, no main treatment effects (P > 0.51) or interactions (P > 0.11) effects were detected for plasma cortisol concentrations (Table 3). During the same period, mean RT and plasma haptoglobin concentrations were reduced (FR treatment effect; P = 0.02) for steers receiving CAM during FR compared to cohorts receiving CO (Figure 1).

These results suggest that, based on similar cortisol concentrations among treatment combinations, all steers experienced a similar stress challenge due to transport and feedlot entry (Crookshank et al., 1979; Sapolsky et al., 2000), whereas CAM supplementation modulated the stress-induced haptoglobin response. More specifically, steers receiving CAM during preconditioning had reduced haptoglobin concentration at the time of transport, whereas steers receiving CAM supplementation after transport had reduced haptoglobin concentrations during FR. Rectal temperature, another key component of the acute-phase response (Carroll and Forsberg, 2007) was also reduced for steers receiving CAM following transportation and feedlot entry. Similar to our previous effort (Cooke et al., 2010), PUFA supplementation during preconditioning improved feedyard performance of beef steers, as reported

herein by the PC treatment effects detected on G:F during FR. On the other hand, PUFA supplementation during FR alleviated the concurrent acute-phase protein response, but did not benefit steer FR performance (Araujo et al., 2010).

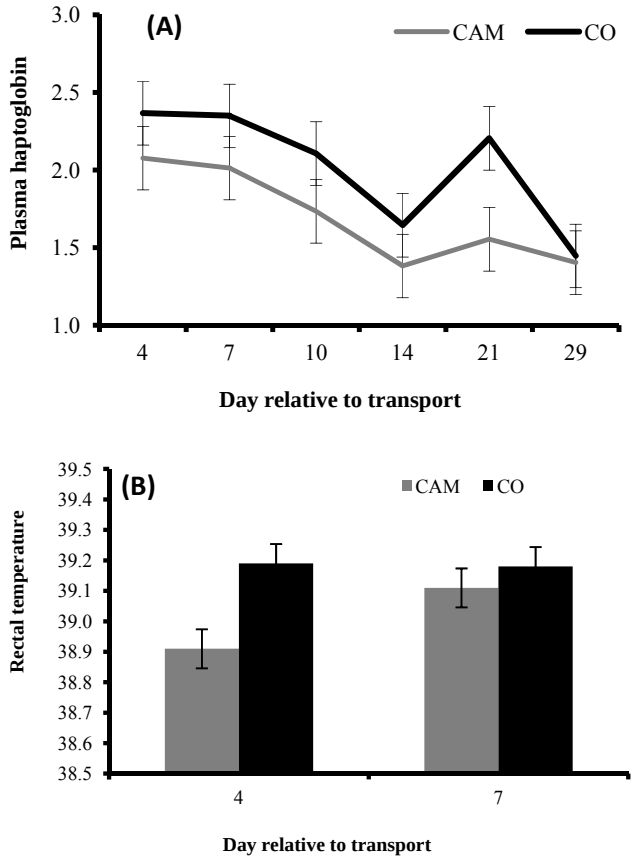

Figure 1. Plasma haptoglobin concentrations (Panel A; absorbance at 450 nm × 100) and rectal temperatures (Panel B; ºC) of steers transported to the feedlot on d 0, and supplemented (CAM) or not (CO) with camelina meal beginning on d 1 of the study. A treatment effect was detected (P = 0.02) for both variables.

Conclusions

Camelina meal supplementation alleviated the acute-phase protein response stimulated by transport and feedlot entry, but benefited, at least partially, feedlot performance of feeder steers if supplemented during preconditioning only.

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Table 3. Feedlot receiving performance and plasma cortisol concentrations of beef steers supplemented (CAM) or not (CO) with camelina meal during preconditioning and/or feedlot receiving.

Item[1]	CAM-CAM	CO-CO	CAM-CO	CO-CAM	SEM	*P* =
Forage DMI, % of BW	2.50	2.63	2.42	2.59	0.05	0.20
Total DMI, % of BW	3.22	3.39	3.18	3.30	0.05	0.20
ADG, [2] kg/d	1.76	1.79	1.78	1.63	0.07	0.31
G:F, [3] kg/kg	0.225	0.221	0.237	0.210	0.009	0.99
Cortisol,[4] ng/mL	29.22	32.42	25.95	29.44	4.68	0.51

[1] Treatment description; first component refers to treatment provided preconditioning phase (CO or CAM), whereas second component refers to treatment provided during feedlot receiving phase (CO or CAM).
[2] Calculating using shrunk values obtained on d 1 and 30.
[3] Calculating using total DMI and BW gain from d 1 to d 28.
[4] Blood samples collected on d 4, 7, 10, 14, 21, and 29 relative to transport (d 0) and feedlot entry (d 1).

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BEEF076

Beef Cattle Sciences

Oregon Beef Council Report

Camelina Meal Supplementation to Beef Cattle: II. Effects on DMI, Forage *in Situ* Digestibility and Plasma Cholecystokinin Concentrations [1]

B. I. Cappellozza[2], R. F. Cooke[2], C. Trevisanuto[2], V. D. Tabacow[2], and D. W. Bohnert[2]

Synopsis

Camelina meal supplementation does not impact forage digestibility but decreases forage and total feed intake in cattle

Summary

Nine Angus × Hereford steers, ranked by initial BW (average 250 ± 9 kg), were assigned (d 0) to receive: 1) supplement based (as-fed basis) on 84% corn, 14% soybean meal, and 2% mineral mix (CO); and 2) supplement based (as-fed basis) on 70% corn, 28% camelina meal, and 2% mineral mix (CAM). Treatments were offered daily (0700 h) at a rate of 2.20 and 2.04 kg of DM/steer for CO and CAM, respectively. Treatment intakes were formulated to be iso-caloric and iso-nitrogenous. Mixed alfalfa-grass hay was offered ad libitum from d 0 to 15, and hay DMI was recorded daily. Intake recorded from d 8 to 15 was used to determine treatment effects on hay and total DMI. From d 16 to d 19, steers were restricted to receive 90% of their voluntary hay DMI (BW basis). Immediately before treatment feeding on d 16, polyester bags (pore size 50-60 μm) containing 4 g of hay (DM basis) were suspended within the rumen of each steer, and incubated in triplicate for 0, 1, 3, 5, 8, 12, 24, 36, 48, 72 and 96 h. After removal, triplicates were washed, dried for 96 h at 50°C, weighed, and combined for NDF analysis. From d 20 to 21, steers received hay ad libitum and blood samples were collected on d 21 at 0, 1, 2, 3, 4, 5, 6, 9, and 12 h relative to treatment feeding for determination of plasma cholecystokinin (CCK) concentrations. Hay DMI tended ($P = 0.15$) to be reduced whereas total DMI was reduced ($P = 0.01$) in CAM vs. CO steers (2.71 vs. 2.91% of BW for hay and 3.46 vs. 3.76% of BW for total DMI, respectively). No treatment effects were detected ($P > 0.35$) for rate of ruminal degradation of DM (7.91 vs. 8.58%/h for CAM and CO) and NDF (7.49 vs. 7.39%/h for CAM and CO). Similarly, no treatment effects were detected ($P > 0.55$) for effective ruminal degradability of DM (64.3 vs. 64.9% for CAM and CO) and NDF (70.1 vs. 71.0% for CAM and CO). No treatment effects were detected ($P = 0.35$) for plasma CKK concentrations (22.7 vs. 26.8 pg/mL for CAM and CO). In conclusion, camelina meal supplementation did not impact forage digestibility and plasma CCK, but decreased total DMI in forage-fed beef steers.

Introduction

Supplemental polyunsaturated fatty acids (PUFA) sources, such as camelina meal, are nutritional alternatives to alleviate the bovine acute-phase response stimulated by transport and feedlot entry (Araujo et al., 2010). However, feeder calves supplemented with PUFA may experience decreased DMI, ADG (Araujo et al., 2010; Cooke et al., 2010a) and feed efficiency (Araujo et al., 2010)

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Oregon State University - Eastern Oregon Agricultural Research Center, Burns, OR.

compared to cohorts offered control diets. Several factors may be associated with these outcomes, including altered dietary palatability (Grummer et al., 1990), impaired dietary digestibility and consequent feed intake (Schauff and Clark, 1989), reduced gut motility and increased cholecystokinin (CCK) synthesis and release (Drackley et al., 1992; Allen et al., 2000). Therefore, the objective of the present study was to compare DMI, in situ forage digestibility, and plasma CCK concentrations in beef steers offered diets with or without camelina meal.

Materials and Methods

This experiment was conducted at the Eastern Oregon Agricultural Research Center – Burns, in accordance with an approved Oregon State University Animal Care and Use Protocol. Nine Angus x Hereford steers were ranked by initial BW (average = 250 ± 9 kg), and assigned on d 0 to 1 of 2 treatments: 1) supplement based (as-fed basis) on 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO); and 2) supplement based (as-fed basis) on 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM). Treatment intakes were formulated to be iso-caloric and iso-nitrogenous, and offered individually and daily (0700 h) at a rate of 2.20 and 2.04 kg of DM/steer for CO and CAM, respectively (Table 1).

Mixed alfalfa-grass hay was offered in amounts to ensure ad libitum access from d 0 to 15 of the study, and hay DMI was recorded daily by measuring refusals. Samples of the offered hay and treatment ingredients were collected weekly to determine nutrient composition (Dairy One Forage Laboratory, Ithaca, NY) and DM, whereas samples of refusals were collected daily to determine DM content only. Hay samples were dried for 96 h at 50°C in forced-air ovens. Intake data collected from d 8 to 15 were used to determine treatment effects on hay and total DMI. From d 16 to 19, steers were restricted to receive 90% of their voluntary hay DMI (BW basis).

Immediately before treatment feeding on d 16, polyester bags (pore size 50-60 μm) containing 4 g (DM basis) of mixed alfalfa-grass hay were suspended within the rumen of each steer, and incubated in triplicates for 0, 1, 3, 5, 8, 12, 24, 36, 48, 72 and 96 h. Prior to incubation, all bags were soaked in warm water (37 °C) for 15 min. The 0-h bags were not incubated in the rumen, but were subjected to the same rising procedure used for ruminally incubated bags. After removal, bags were washed repeatedly until the rinse water was colorless, dried for 96 h at 50°C in forced-air ovens, and weighed. Triplicates were combined and analyzed for NDF (Robertson and Van Soest, 1981) using procedures modified for use in an Ankom 200 Fiber Analyzer (Ankom CO., Fairport, NY).

From d 20 to 21, steers received hay ad libitum and blood samples were collected on d 21 at 0, 1, 2, 3, 4, 5, 6, 9, and 12 h relative to treatment feeding for determination of plasma CCK concentrations (KT-10170; Kamiya Biomedical Company, Seattle, WA)

Table 1. Composition and nutrient profile of supplements offered during the study.

Item	CO	CAM
Ingredient, DM basis		
Corn, kg	1.82	1.39
Soybean Meal, kg	0.32	--
Camelina, kg	--	0.59
Mineral Salt, kg	0.06	0.06
Nutrient profile, DM basis		
DM, %	87.0	88
TDN, %	94	95
CP, %	14.7	15.6
NDF, %	9.6	14.7
Ether extract, %	4.5	9.8
Ca, %	0.1	0.3
P, %	0.4	0.5

Voluntary forage, total DMI, and plasma CCK concentrations were analyzed using the PROC MIXED procedure of SAS (SAS Inst., Inc., Cary, NC) and Satterthwaite approximation to determine the denominator df for the tests of fixed effects. The model statements contained the effects of treatment, day, and the interaction. Data were analyzed using steer(treatment) as the random variable. Kinetic parameters of hay DM and NDF disappearance were estimated using nonlinear regression procedures of SAS, as described by Vendramini et al. (2008). Treatment effects on ruminal degradation rate and effective ruminal degradability (Coblentz and Hoffman, 2009) were analyzed using the PROC MIXED procedure of SAS and Satterthwaite approximation to determine the denominator df for the tests of fixed effects. The model statement contained the effect of treatment. Data were analyzed using steer(treatment) as random variable. Results are reported as least square means and were separated using LSD. Significance was set at $P \leq 0.05$, and tendencies were determined if $P > 0.05$ and ≤ 0.15.

Results are reported according to treatment effects if no interactions were significant.

Results

Steers receiving CAM had decreased (P = 0.01) total DMI compared to CO cohorts, whereas a trend (P = 0.15) was observed for forage DMI (Figure 1). Our results support previous efforts reporting that PUFA supplementation reduced DMI in cattle (Araujo et al., 2010; Cooke et al., 2010a; Cooke et al., 2010b). The reasons for this outcome may include impaired dietary digestibility (Schauff and Clark, 1989), as well as reduced gut motility and increased CCK synthesis and release (Drackley et al., 1992; Allen et al., 2000).

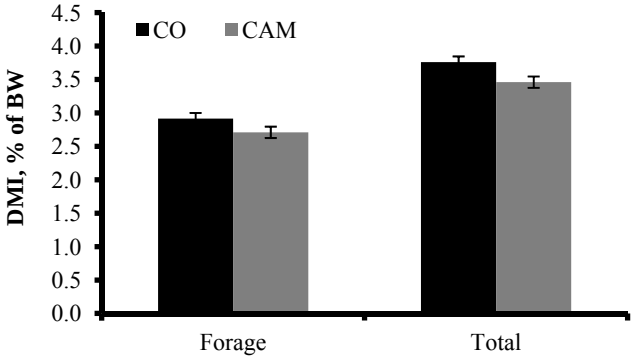

Figure 1. Forage and total DMI, as percentage of BW, of steers offered supplements containing (CAM) or not (CO) camelina meal. A trend (P = 0.15) was detected for forage DMI, whereas a treatment effect was detected (P = 0.01) for total DMI.

However, no treatment effects were detected (P > 0.35) on ruminal degradation rate (K_d) of hay DM and NDF (Table 2). Similarly, no treatment effects were detected (P > 0.55) for effective ruminal degradability of hay DM and NDF (Table 2). Accordingly, previous research from our group reported that ruminal digestibility parameters are not affected by PUFA supplementation, even when forage and total DMI are impaired (Cooke et al., 2010b); Plasma CCK concentrations were not different (P = 0.35) between CAM and CO steers (Figure 2). These results were not expected, since CCK is related to satiety (Baile et al., 1986) and fat supplementation has been shown to decrease DMI while increasing plasma CCK concentrations (Choi et al., 2000).

Table 2. In situ disappearance kinetics of DM and NDF of mixed alfalfa-grass hay incubated in steers offered supplements containing (CAM) or not (CO) camelina meal.

Treatment	K_d, /h	Effective degradability, [1] %
DM analysis		
CO	0.085	64.95
CAM	0.079	64.30
SEM	0.005	0.008
P-value	0.35	0.57
NDF analysis		
CO	0.074	70.98
CAM	0.075	70.15
SEM	0.006	0.01
P-value	0.91	0.55

[1] Calculated as $A + B \times [(K_d + K_p)/K_d]$, where K_p was the ruminal passage rate, which was arbitrarily set at 0.025/h (Coblentz and Hoffman, 2009).

Conclusions

These results indicate that camelina meal supplementation did not impact forage digestibility and plasma CCK concentrations, but decreased total DMI in beef steers. Therefore, additional research is needed to understand the mechanisms by which PUFA supplementation reduces feed intake in cattle.

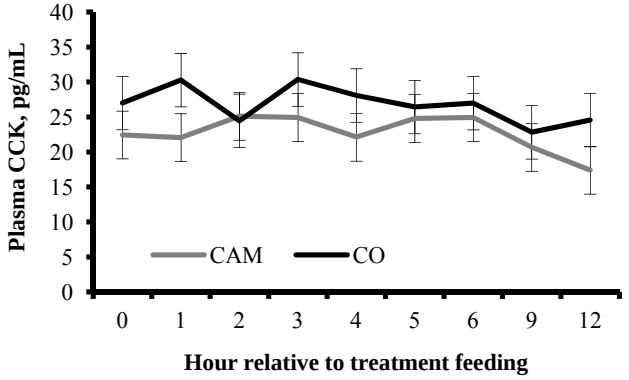

Figure 2. Plasma cholecystokinin (CCK) concentrations of steers offered supplements containing (CAM) or not (CO) camelina meal (P = 0.35).

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Oregon State University

BEEF077

Beef Cattle Sciences

Oregon Beef Council Report

Camelina Meal Supplementation to Beef Cattle: III. Effects on Acute-Phase and Thyroid Responses [1]

B. I. Cappellozza[2], R. F. Cooke[2], C. Trevisanuto[2], V. D. Tabacow[2], D. W. Bohnert[2] J. Dailey[3] and J. A. Carroll[3]

Synopsis

Camelina meal supplementation does not impair thyroid gland function and alleviates stress-induced inflammatory reactions

Summary

Fourteen halter-trained Angus steers were ranked by initial BW (average 191 ± 2.1 kg), and assigned (d 0) to receive supplements containing (as-fed basis): 1) 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO); and 2) 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM). Treatments were offered individually, at a daily rate of 1.65 and 1.52 kg of DM/steer for CO and CAM, respectively. Alfalfa-grass hay was offered ad libitum during the study (d 0 to 36). On d 24, steers were fitted with a jugular catheter and were infused (i.v.) on d 25 with 0.5 µg of bovine corticotropin-releasing hormone (CRH)/kg of BW. Blood samples were collected hourly from –2 to 0 h and 4 to 8 h, and every 30 min from 0 to 4 h relative to treatment infusion (0 h). Blood samples were also collected via jugular venipuncture every 6 h from 12 to 72 h, and every 24 h from 96 to 168 h. All samples were analyzed for plasma concentrations of cortisol, ceruloplasmin, and haptoglobin. No treatment effects were detected (P = 0.28) for cortisol concentrations, which peaked for both treatments at 0.5 h relative to CRH infusion (time effect; P < 0.01). Ceruloplasmin concentrations were greater for CO vs. CAM steers at 6, 18, 42, 120, 144, and 168 h relative to CRH infusion (treatment × time interaction, P < 0.01). Mean haptoglobin concentrations tended to be greater (P = 0.10) for CO vs. CAM steers (1.73 vs. 1.54 absorbance @ 450 nm × 100, respectively). On d 34, steers were again fitted with a jugular catheter and were infused (i.v.) on d 35 with 0.33 µg of bovine thyrotropin-releasing hormone (TRH)/kg of BW. Blood samples were collected hourly from –2 to 0 h and 4 to 8 h, every 30 min from 0 to 4 h, and every 4 h from 8 to 24 h relative to treatment infusion (h 0) for determination of serum T_3 and T_4. No treatment effects were detected for T_3 (P = 0.58) and T_4 (P = 0.54) concentrations, which peaked, respectively, at 3 and 5 h relative to TRH infusion in both treatments. In conclusion, camelina meal supplementation did not affect thyroid gland function following a TRH challenge, but alleviated the acute-phase protein response following a CRH challenge in beef steers.

Introduction

The acute-phase response is an important component of the innate immune system, but it can be detrimental to cattle performance, particularly when stimulated by stressors such as weaning, transport and feedlot entry (Duff and Galyean, 2007; Araujo et al., 2010, Cooke et al., 2010). Alternatives to prevent this reaction, including supplementation

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Oregon State University - Eastern Oregon Agricultural Research Center, Burns, OR.
3. Livestock Issues Research Unit, Agricultural Research Service – USDA, Lubbock, TX

of polyunsaturated fatty acids (PUFA), are thus beneficial to cattle productivity (Cooke et al., 2010). Moreover, Cooke and Bohnert (2011) reported that corticotropin-releasing hormone (CRH) challenge stimulates an acute-phase response in cattle, and this research model can be used to investigate the physiological components and develop alternatives to modulate the stress-induced acute-phase response. Camelina meal results from the mechanical processing of the seeds for oil extraction, and may contain up to 20% oil with the majority of the fatty acid content as PUFA (Moriel et al., 2010). Therefore, camelina meal may serve as a nutritional alternative to modulate the acute-phase response in cattle subjected to stress of management. However, camelina meal contains elevated concentrations of glucosinolates, which may impair thyroid gland activity in cattle (Lardy and Kerley, 1994) resulting in impaired growth rates (Burel et al., 2001). However, Moriel et al. (2010) reported that camelina meal supplementation did not impair thyroid function in beef heifers. Therefore, we hypothesized that camelina meal supplementation alleviates stress-induced acute-phase responses without impairing thyroid function in beef cattle. The objectives of this study were to evaluate the effects of camelina meal supplementation on concentrations of acute-phase proteins and thyroid hormones in beef steers following a CRH and thyrotropin-releasing hormone (TRH) challenges, respectively.

Materials and Methods

The experiment was conducted in accordance with an approved Oregon State University Animal Care and Use Protocol. Fourteen weaned Angus steers were utilized in these studies. All steers were exposed daily (d -60 to d 0) to halter-training techniques to become acclimated to human interaction; thus preventing confounding effects between human handling, weaning and hormone challenges measured herein (Cooke et al., 2009). Steers were ranked by initial BW (average 191 ± 2.1 kg), and assigned on d 0 to receive 1 of 2 treatments: 1) supplement containing (as-fed basis) 84 % corn, 14 % soybean meal, and 2 % mineral mix (CO); and 2) supplement containing (as-fed basis) 70 % corn, 28 % camelina meal, and 2 % mineral mix (CAM). Treatment intakes were formulated to be iso-caloric and iso-nitrogenous, and offered individually at a daily rate of 1.65 and 1.52 kg of DM/steer for CO and CAM, respectively. Alfalfa-grass hay was offered ad libitum during the study (d 0 to 36).

On d 24 and 34 of the study, steers were fitted with a jugular catheter according to procedures described by Merrill et al. (2007), and were infused (i.v.) on d 25 and 35 with 0.5 µg of bovine CRH/kg of BW (Exp. 1) and 0.33 µg of bovine TRH/kg of BW (Exp. 2), respectively. In Exp. 1, blood samples were collected hourly from –2 to 0 h and 4 to 8 h, and every 30 min from 0 to 4 h relative to treatment infusion (0 h) via jugular catheters. Blood samples were also collected via jugular venipuncture every 6 h from 12 to 72 h, and every 24 h from 96 to 168 h. All samples were analyzed for plasma concentrations of cortisol, ceruloplasmin, and haptoglobin. In Exp. 2, blood samples were collected via jugular catheters hourly from –2 to 0 h and 4 to 8 h, every 30 min from 0 to 4 h, and every 4 h from 8 to 24 h relative to treatment infusion (h 0) for determination of serum T_3 and T_4. Blood samples were harvested for plasma and serum, and stored at −80°C until assayed for plasma concentrations of cortisol Endocrine Technologies Inc., Newark, CA), ceruloplasmin (Demetriou et al., 1974) and haptoglobin (Makimura and Suzuki, 1982), and serum concentrations of T_3 and T_4 (Endocrine Technologies Inc.).

Data from Exp. 1 and 2 were analyzed using the PROC MIXED procedure of SAS (SAS Inst., Inc., Cary, NC) and Satterthwaite approximation to determine the denominator df for the tests of fixed effects. The model statement contained the effects of treatment, time, and the interaction. Data were analyzed using steer(treatment) as the random variable. The specified term for the repeated statement was time and the covariance structure utilized was autoregressive, which provided the best fit for these analyses according to the Akaike information criterion. Results are reported as least square means and separated using LSD. Significance was set at $P \leq 0.05$, and tendencies were determined if $P > 0.05$ and ≤ 0.10. Results are reported according to treatment effects, or according to the highest-order interaction detected.

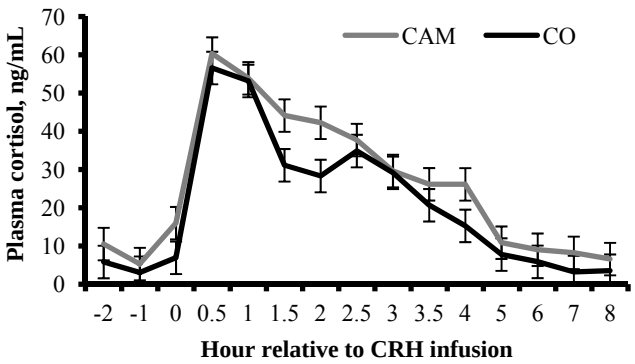
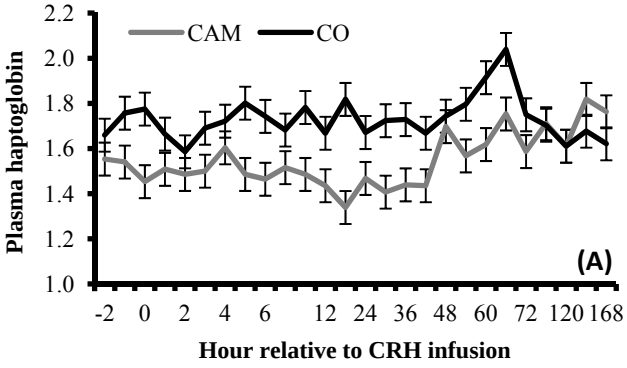


Figure 1. Plasma cortisol concentrations of steers supplemented (CAM) or not (CO) with camelina meal and receiving 0.5 µg of bovine corticotropin-releasing hormone (CRH)/kg of BW at h 0. No treatment effect (P = 0.28) or treatment × time interaction (P = 0.09) were detected.

Results

In Exp. 1, no treatment (P = 0.28) effects were observed for cortisol concentrations (Figure 1). Steers receiving CAM tended (P = 0.10) to have reduced mean haptoglobin concentrations compared to CO steers (1.54 vs. 1.73 absorbance @ 450 nm × 100, respectively; Figure 2). A treatment x time interaction (P < 0.001) was detected for ceruloplasmin concentrations, because CAM steers had reduced ceruloplasmin concentrations compared with CO steers at 6, 18, 42, 120, 144, and 168 h relative to CRH infusion (Figure 2). These results suggest that CAM and CO steers experienced a similar increase in plasma cortisol concentrations (Cooke and Bohnert, 2011), but camelina meal supplementation reduced the acute-phase protein response stimulated by the CRH challenge. Similarly, previous research from our group reported that PUFA supplementation alleviated the acute-phase response in beef steers following transport and feedlot entry (Cooke et al., 2010).



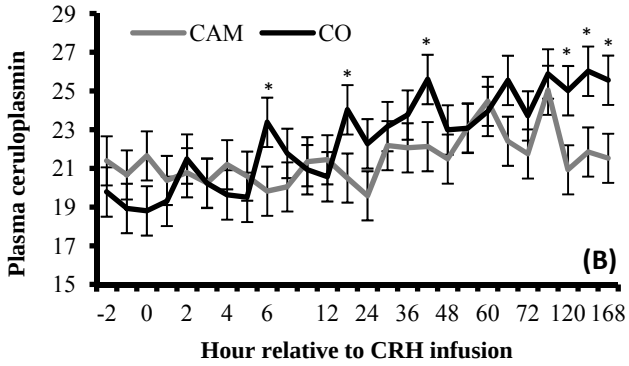
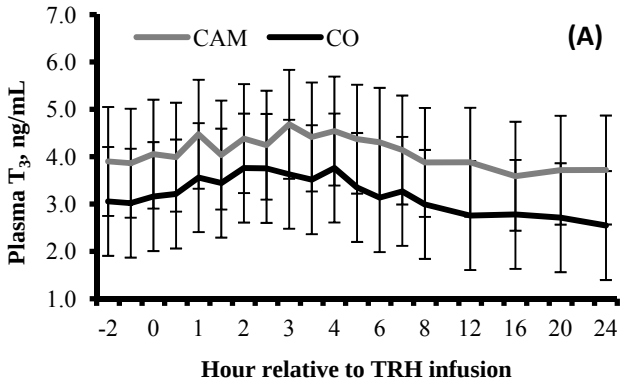


Figure 2. Plasma haptoglobin (panel A; absorbance at 450 nm × 100) and ceruloplasmin (panel B; mg/dL) concentrations of steers supplemented (CAM) or not (CO) with camelina meal and receiving 0.5 µg of bovine corticotropin-releasing hormone (CRH)/kg of BW at h 0. Steers receiving CAM tended (P = 0.10) to have reduced mean haptoglobin concentrations compared to CO steers. A treatment × time interaction was detected for ceruloplasmin concentrations (treatment comparison within time: * P < 0.05).

In Exp. 2, no treatment effects were detected for serum T_3 (P = 0.58) and T_4 (P = 0.55) concentrations, which peaked, respectively, at 3 and 5 h relative to TRH infusion in both treatments (Figure 3). Moriel et al. (2010) reported that heifers fed camelina meal had greater T_3 concentrations compared to cohorts fed a corn-soybean meal diet, whereas no differences were detected for serum T_4 concentrations. Therefore, camelina meal does not impair thyroid gland function in beef cattle when supplemented at the rates utilized herein and by Moriel et al. (2010).



Conclusions

Camelina meal supplementation did not impair thyroid gland function following a TRH challenge, but alleviated the acute-phase protein response stimulated by CRH challenge in beef steers.

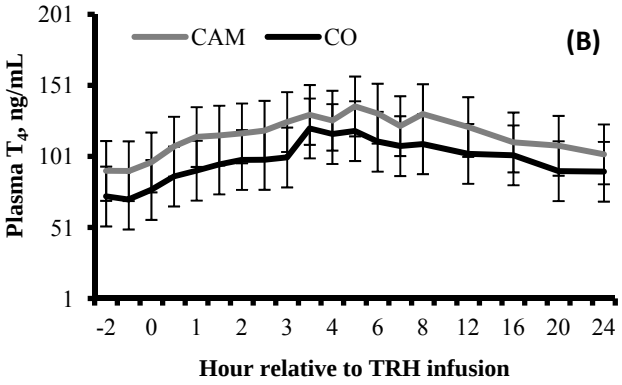


Figure 3. Plasma concentrations of T_3 (panel A) and T_4 (panel B) of steers supplemented (CAM) or not (CO) with camelina meal and receiving 0.33 µg of bovine thyrotropin-releasing hormone (TRH)/kg of BW at h 0. No treatment effects were detected (P > 0.55)

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Oregon State University

BEEF078

Beef Cattle Sciences

Oregon Beef Council Report

Effects of Temperament on Performance and Carcass Traits of Range-Originated Feeder Calves [1]

R. F. Cooke[2], D. W. Bohnert[2], and R. R. Mills[3]

Synopsis

Feeder calves with aggressive temperament have impaired weaning weights and such difference persists until slaughter, resulting in impaired carcass quality.

Summary

The objective was to evaluate the effects of temperament on performance and carcass traits of feeder calves originated from a range cow-calf operation. Ninety-seven Angus × Hereford calves (62 heifers and 35 steers) were evaluated for BW and temperament at weaning (d 0). Temperament was assessed by chute score (1–3 scale) and exit velocity (EV), which was subsequently converted into an EV score (1 = EV < 1 SD from the mean; 2 = EV within 1 SD from the mean, and 3 = EV > 1 SD from the mean). Calves were classified for temperament according to combined chute and EV scores [calm < 2 (n = 56), moderate = 2 (n = 25), and aggressive > 2 (n = 16)]. All calves were managed similarly in a single group during the preconditioning (60 d), growing (137 d), and finishing (110 d) phases. Calf BW was determined at the end of each phase. Trained personnel and a USDA grader evaluated carcass traits following a 24-h chill. Weaning age was similar (P = 0.59) across temperament classes. Weaning BW tended (P = 0.10) to be reduced for aggressive vs. moderate and calm calves (185.8, 192.0, and 197.8 kg, respectively). Average weaned calf value was $629.5, $656.5, and $656.7 for aggressive, calm, and moderate calves, respectively. No temperament effects were detected (P > 0.23) on performance during preconditioning, growing, or finishing phases. However, hot carcass weight tended (P = 0.15) to be reduced for aggressive vs. moderate and calm calves (352.5, 363.3, and 362.2 kg, respectively). Backfat thickness and KPH were reduced (P < 0.03) for aggressive vs. moderate and calm calves (1.20, 1.47, and 1.33 cm of backfat; 2.02, 2.44, and 2.46% for KPH, respectively). Carcass yield grade was improved (P = 0.04) whereas marbling score tended to be reduced (P = 0.09) for aggressive vs. moderate and calm calves (2.71, 3.15, and 2.99 for yield grade; 422, 460, and 445 for marbling score, respectively). Average carcass value was $1,102.5, $1,151.7, and $1,119.2 for aggressive, moderate, and calm calves, respectively. In summary, aggressive temperament is detrimental to performance and profitability of range-originated feeder calves at weaning and upon slaughter.

Introduction

For over a century, temperament has been defined as the behavioral responses of cattle when exposed to human handling (Fordyce et al., 1988). As cattle temperament worsens, their response to human contact or any other handling procedures

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Oregon State University - Eastern Oregon Agricultural Research Center, Burns, OR.
3. Oregon State University - Umatilla County Extension Office, Pendleton, OR.

becomes more aggressive and excitable. Cattle temperament has been shown to be detrimental not only to personnel safety, but also to productivity of beef operations. As an example, our research group demonstrated that aggressive beef females have reduced reproductive performance compared to cohorts with adequate temperament (Cooke et al., 2009; Cooke et al., 2010).

However, the deleterious effects of excitable temperament in cattle are not limited to reproduction. Previous research reported that feedlot calves with excitable temperament have decreased growth rates compared to calm cohorts (Voisinet et al., 1997a). These outcomes were mainly attributed to reduced feed intake because temperamental cattle spend more time inspecting their surroundings and reacting against "threats" instead of consuming their diets (Nkrumah et al., 2007). Also, excitable temperament has detrimental effects on carcass quality by decreasing final carcass weight, carcass yield grade, and meat tenderness, and increasing percentage of bruised and dark carcasses (Fordyce et al., 1988; Voisinet et al., 1997b). However, all the research studies associating temperament and feedlot performance evaluated calves originated from cowherds maintained in drylot and intensive systems, which differ in terms of overall temperament compared to the herds reared in Oregon's extensive rangeland scenarios (Fordyce et al., 1985). Also, the majority of research studies associating temperament and carcass quality evaluated *Bos indicus* cattle, and similar studies should be conducted with *B. taurus* cattle, which commonly exhibit excitable temperament and represent the majority of calves in the Oregon and U.S. beef industry. Therefore, the objective of this study was to evaluate the effects of temperament on performance and carcass traits of *B. taurus* feeder calves originated from a range cow-calf operation.

Materials and Methods

The experiment was conducted in accordance with an approved Oregon State University Animal Care and Use Protocol, and was divided into preconditioning (d 0 to 60), growing (d 61 to 197) and finishing phases (d 198 to 307). The preconditioning phase was conducted at the Eastern Oregon Agricultural Research Center, Burns. The growing (Top Cut; Echo, OR) and finishing (Beef Northwest; Boardman, OR) phases were conducted at commercial feedyards.

Ninety-seven Angus × Hereford calves (62 heifers and 35 steers) were evaluated for BW and temperament at weaning (d 0). Temperament was assessed by chute score and chute exit velocity (EV). More specifically, chute score was assessed by a single technician when calves were restrained in the chute based on a 3-point scale, where 1 = no movement or occasional shifting, 2 = constant shifting with occasional shaking of the chute, and 3 = continuous and violent movement and shaking of the chute. Chute EV was achieved by determining the speed of the calf exiting the squeeze chute by measuring rate of travel over a 1.8-m distance with an infrared sensor (FarmTek Inc., North Wylie, TX). Chute EV was subsequently converted into an EV score (1 = EV < 1 SD from the mean; 2 = EV within 1 SD from the mean, and 3 = EV > 1 SD from the mean). Calves were classified for overall temperament class according to combined chute and EV scores [calm < 2 (n = 56), moderate = 2 (n = 25), and aggressive > 2 (n = 16)]. All calves were managed similarly in a single group during the preconditioning, growing, and finishing phases. Calf BW was determined at the end preconditioning and growing phases. Calves were slaughter at a commercial packing facility (Tyson Fresh Meats, Inc.; Pasco, WA) at the end of the finishing phase. Hot carcass weight was collected at slaughter. Finishing BW was calculated based on hot carcass weight adjusted to a 63% dressing percentage (Loza et al., 2010). Following a 24-h chill, trained personnel assessed carcass backfat thickness at the 12^{th}-rib and LM area, whereas all other carcass measures were recorded from a USDA grader. Calf value at weaning or upon preconditioning were calculated based on local prices (available at: http://www.centraloregonlivestockauction.com/marketreports.htm; assessed on February 25, 2011). Carcass sale value was $143.70 per 45 kg of hot carcass weight.

Data were analyzed using the PROC MIXED procedure of SAS (SAS Inst., Inc., Cary, NC) and Satterthwaite approximation to determine the denominator df for the tests of fixed effects. The model statement used for performance traits contained the effects of temperament class (calm, moderate, or aggressive), sex, and the resultant interaction. Data were analyzed using calf (temperament × sex) as the random variable. Results are reported as least square means and separated using a single-df orthogonal contrast (aggressive vs. calm and moderate). Significance was set at $P \leq$

0.05, and tendencies were determined if $P > 0.05$ and ≤ 0.15.

Results

No temperament × sex interactions were detected for any of the variables analyzed (P > 0.24); therefore, all results reported herein include data from steers and heifers All performance results are described in Table 1. Weaning age was similar (P = 0.59) across temperament classes. However, aggressive calves tended (P = 0.10) to have reduced weaning BW compared to calm and moderate cohorts. No differences were detected for preconditioning ADG (P = 0.91), hence aggressive calves also tended (P = 0.14) to have reduced BW at the end of preconditioning compared to control and moderate cohorts. As a result, calf value at weaning or after preconditioning was the lowest for aggressive calves. No temperament effects were detected for BW and ADG during growing and finishing phases.

Table 1. Performance traits of calves according to temperament at weaning.

	Temperament[1]				
Item[2]	C	M	A	SEM	*P*[3]
Weaning age, d	152.3	151.6	148.5	2.4	0.34
Weaning BW, kg	197.8	192.0	185.8	3.9	0.10
Weaning value, $	656.5	656.7	629.5	-	-
Preconditioning ADG, kg/d	0.23	0.31	0.28	0.04	0.91
Preconditioning BW, kg	211.7	210.9	202.6	4.0	0.14
Preconditioning value, $	700.6	714.5	690.4	-	-
Growing phase ADG, kg/d	1.16	1.17	1.18	0.03	0.51
Growing phase BW, kg	370.8	370.8	365.6	5.4	0.51
Finishing phase ADG, kg/d	1.78	1.80	1.70	0.05	0.23
Finishing phase BW, kg	572.4	576.7	559.6	8.7	0.23

[1] Temperament classification based on chute score and exit velocity; C = calm temperament, M = moderate temperament, and A = aggressive temperament.
[2] All calves were managed similarly in a single group during the preconditioning (60 d), growing (137 d), and finishing (110 d) phases. Calf BW was determined at the end of preconditioning and growing phases. Finishing BW was calculated based on hot carcass weight (assuming 63% dressing; Loza et al., 2010).
[3] P-value relative to single-df orthogonal contrast (aggressive vs. calm and moderate).

All carcass results are described in Table 2. Hot carcass weight tended (P = 0.15) to be reduced for aggressive calves compared to calm and moderate cohorts. Backfat thickness and KPH were also reduced (P < 0.03) in aggressive calves compared to calm and moderate cohorts. Carcass yield grade was improved (P = 0.04) whereas marbling score tended to be reduced (P = 0.09) for aggressive vs. moderate and calm calves. As a result, mean carcass sale value was the lowest for aggressive calves.

Table 2. Carcass traits of calves according to temperament at weaning.

	Temperament[1]				
Item[2]	C	M	A	SEM	*P*[3]
Hot carcass weight, kg	362.2	363.3	352.5	5.4	0.15
Fat,[4] cm	1.33	1.47	1.20	0.06	0.03
LM area, cm^2	87.9	87.5	87.6	1.6	0.96
KPH, %	2.46	2.44	2.02	0.11	0.01
Yield grade [5]	2.99	3.15	2.71	0.12	0.04
Marbling [6]	444.7	459.9	422.7	12.1	0.09
Retail product,[7] %	49.8	49.4	50.4	0.3	0.03
Carcass sale value, $	1,119.2	1,151.7	1,102.5	-	-

[1] Temperament classification based on chute score and exit velocity; C = calm temperament, M = moderate temperament, and A = aggressive temperament.
[2] All calves were managed similarly in a single group during the preconditioning (60 d), growing (137 d), and finishing (110 d) phases. Calf BW was determined at the end of each phase for ADG calculation.
[3] P-value relative to single-df contrast (aggressive vs. calm and moderate)
[4] Backfat thickness measured at the 12th rib.
[5] Calculated as reported by Lawrence et al. (2010).
[6] Marbling score: 400 = Small^{00}, 500 = Modest^{00}.
[7] USDA Retail Yield Equation = 51.34 – (5.78 × backfat) – (0.0093 × hot carcass weight) – (0.462 × KPH) + (0.74 × LM area).

These results indicate that calves with aggressive temperament were lighter at weaning compared to cohorts with adequate temperament (calm and moderate temperament), and this BW difference persisted until slaughter based on results detected for hot carcass weight. Further, aggressive calves had reduced carcass backfat and marbling compared to cohorts with adequate temperament, which suggests that carcass development and fat deposition was delayed in aggressive calves mainly due to reduced weaning BW. Differently than previous research efforts (Nkrumah et al., 2007; Cafe et al., 2010), temperament did not influence feedlot ADG in the present study. However, to our knowledge, the effects of temperament on weaning BW are novel, influence calf overall productivity, and potentially impact profitability of beef producers that either market calves at weaning or retain

ownership until slaughter. The reasons to why aggressive calves were lighter at weaning is unknown and deserve further investigation. Potential theories include reduced milk production and maternal ability of aggressive brood cows rearing aggressive calves given that temperament is a moderately heritable trait (Shrode and Hammack, 1971; Stricklin et al., 1980), reduced milk and feed intake of aggressive sucking calves, detrimental effects of temperament on calf health and physiologic parameters (Cooke et al., 2009; Burdick et al., 2010), or even a direct genetic interactions among temperament and performance traits. Therefore, additional research is warranted to assess the relationship between temperament and weaning weights in beef calves.

Conclusions

Range-originated feeder calves with aggressive temperament have impaired BW at weaning compared to cohorts with adequate temperament, and such BW difference persists until slaughter and results in impaired carcass quality. Therefore, temperament directly impacts profitability of range beef operations that market calves at weaning, or retain ownership until slaughter.

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Oregon State University

BEEF074

Beef Cattle Sciences

Oregon Beef Council Report

Improving Calf Performance by Extending the Grazing Season with Warm Season Grasses and Brassica Forages [1]

Shelby Filley[2] and Janice Hunter[3]

Synopsis

Spring planted warm-season grasses and brassica forages increased nutritional content of the diet available to grazing cow-calf pair, but pastures were slow to establish and weaning weights were not improved.

Summary

The objective of this experiment was to determine whether grazing cow-calf pairs on warm season grasses and brassica pastures would extend the grazing season and positively affect calf weaning weights, feedlot performance, carcass characteristics, and ranch profitability. Treatments were pasture type, extended season pasture (EXT) made of newly planted sorghum × Sudangrass and brassica forages and control pasture (CON) from an existing field of cool season forage. Thirty cow-calf pairs (steers only) were stratified by calf weight and assigned to treatments randomly. Each pasture type was divided into 3, 5-ac paddocks (replicates of experimental unit) and grazed with 5 cow-calf pair until late summer weaning. Cool spring weather slowed EXT establishment and growth so that grazing was delayed until mid-August, allowing for only a 14-d grazing period. Forage yield of EXT tended to be lower than that of CON (2.2 and 3.4 t/ac, respectively). In contrast, CP (10.3% and 6.7%) and TDN (69% and 56%) were higher ($P < .04$) for EXT compared to CON, respectively. Calf weaning weights (205-d adjusted) were not different ($P = 0.167$) for EXT and CON (637.2 and 679.2, respectively). In yr 2, planting strategy was adjusted. However, growing conditions were again less than optimal, pasture was not sufficient for grazing, and no additional data were obtained. Early establishment of warm season forages in the Pacific Northwest can be severely impacted by weather, making it difficult to graze spring calving, cow-calf pair for the purpose of improving early summer weaning weight.

Introduction

Calf weaning weight is influenced by attributes of the sire and dam, the calf itself, and environmental factors. Age and sex of calf sex and age of dam were recognized by Minyard and Dinkel, (1965) and milk yield documented by Rutledge et al. (1971) as having significant effects on calf weaning weight. And, we know that a major determinant of milk yield is the quality and quantity of feed a cow receives during lactation.

The nutrient content and digestibility of cool season forages decreases as the forage matures and environmental conditions warm in the late spring

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Professor, Oregon State University Extension Service, Roseburg 97470. Email: shelby.filley@oregonstate.edu.
3. Manager, Oregon State University Soap and Berry Creek Beef Ranches. Corvallis, 97330. Email: janice.hunter@oregonstate.edu.

and early summer. During the summer months, protein and energy of most western Oregon forages dip below the nutritional requirement of lactating cows and growing calves, limiting milk production and calf growth. Increasing calf weaning weights can improve profitability of beef ranches if the cost of that gain is low relative to sale price of the added gain.

Warm season grasses, such as sorghum × Sudangrass (S×S), have young, fast growing (vegetative) foliage throughout most of the summer months, and have high nutritional value compared to animal nutrient requirements (Armah-Agyeman et al., 2002; NRC, 2000). These forages can be used to extend the grazing season beyond the time when cool season forages decrease growth or go dormant, and decrease in quality. Additionally, forage brassicas can be planted in the spring or fall to augment these and other forages. Producers in western Oregon have planted the above forage types together for use in grazing sheep and lambs, weaned calves, and adult cattle. There is potential for grazing lactating cows and calves (cow-calf pairs) on S×S and brassica forages for the purpose of improving calf weaning weights. Negative consequences to livestock grazing these types of forages include the possibility of prussic acid and nitrate poisoning, goiters, and digestive upset (Undersander et al., 2011). Producers and service providers in Oregon need more information on growing and using the plants for feeding livestock.

Feedlot performance and carcass characteristics are influenced by previous management and plane of nutrition (Tatum et al., 1988). Cattle subject to novel forages could have differences in growth and end product. Therefore it is prudent to follow these attributes when trying new forages and feeding regimens.

At the Oregon State University Soap Creek beef ranch, livestock graze non-irrigated pastures containing predominantly tall fescue, subterranean clover, and annual and perennial ryegrass. Calf weaning weight could be limited by the decrease in quality of these forages in the summer. Therefore, management was seeking to economically increase calf weaning weights through improving plane of nutrition for lactating cows and providing high quality forages for their suckling calves.

The objective of this experiment was to compare weaning weight of calves where cow-calf pair grazed S×S and brassica forages to extend the grazing season (EXT) compared to those grazing conventional, cool-season forages in control pastures (CON). Additional evaluations of the calves included feedlot performance and carcass characteristics. Other objectives of this study included providing a demonstration, teaching, and learning venue for faculty, students, and beef industry producers and service providers; and to provide recommendations on production methods, safe grazing, and economic information on effectively utilizing these forages.

Materials and Methods

Pastures (15 ac each) were set up in western Oregon at a site where soils dry out mid-spring each year and ambient temperatures reach in excess of 90° during the summer. Control pastures used cool season forages (tall fescue, ryegrass, subterranean clover, and meadow foxtail) that were already established on the site. To condition the forage for use in this trial, the pasture was grazed down to three inches and then allowed to regrow for use as the CON pasture. At the time of graze-down of CON, pastures for the EXT were established by planting S×S (variety, Green Treat A+ at 20 lb/ac seeding rate) and brassicas (Graza Grazing Radish and Hunter Turnip, both at 2 lb/ac). Seed was drilled into a well-prepared seedbed and the planting rolled to firm the ground. A mid-May planting time was chosen in order to ensure good moisture for establishing the pasture and to provide a 60-day grazing period (early July through calf weaning in September) for the experiment. Field fence was used to secure the pasture perimeters, and water, trace mineral salt, and round bale feeders (EXT only) were set up. Each pasture type (EXT and CON) was divided into 3, 5-ac paddocks using electric fencing. Thirty cow-calf pairs (steers only) from a spring calving herd were stratified by calf weight and assigned randomly to treatment paddocks (experimental unit). That is, each treatment (CON and EXT) was replicated 3 times (paddocks) using 5 cow-calf pairs per paddock.

Forage yield was estimated at the start of the experimental grazing period from samples collected using a 0.1 meter square hoop (4 hoops per paddock). Samples were weighed in the field using a tarp and scale system. Forage Quality was estimated from samples collected from paddocks over the growing season. All samples were placed in plastic bags and stored in the refrigerator for up to 1 wk and then dried in a forced-air forage drier on the OSU Corvallis campus. Samples were then placed in paper bags and stored for laboratory analysis and

calculations, including dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (ADF), non-fiber carbohydrates (NFC), total digestible nutrients (TDN), and relative feed value (RFV).

Prior to the start of the grazing period, readiness of EXT pastures for grazing was assessed by monitoring plant height (minimum 18 in) and anti-quality factors, prussic acid (hydrocyanide or HCN gas) and nitrates. The presence of prussic acid was evaluated using Cyantesmo Paper (Macherey-Nagel GmbH & Co. KG, Dueren, Germany) and the presence of nitrates was evaluated using Nitrate Precision Test Strips (Sargent-Welch, Buffalo, NY). Details on the use of these tests on forage are available at http://extension.oregonstate.edu/douglas/lf (Item 1. Information; Item 3. Pasture; see Prussic Acid and Nitrate Testing). Cow-calf pairs that had been grazing cool season forage on an adjacent pasture were acclimated to their treatments (EXT and CON) by introducing them to small sections of their pastures, 2 hours at a time for 3 days. To guard against digestive upset from the new forages, cattle in EXT had free access to low quality (7 % CP) grass and clover hay placed in round bale feeders.

During the experimental grazing period, paddocks were strip-grazed with cattle controlled using a single line of electric fence wire. The grazing period started at pasture readiness (mid-Aug) and continued until calf weaning time (Sept 1st). Under these conditions the grazing trial was limited to 14 days. Pairs were gathered from pastures and herded to nearby facilities where they were separated. Cows were evaluated for pregnancy status, and calves were weighed immediately after. Unshrunk, off-the-cow calf weaning weights, adjusted to 205 days of age, were calculated (BIF 2010).

The experiment was repeated for a second year. To improve establishment and growth of S×S, EXT pasture was planted at a soil temperature of 60° F (mid-June reading from nearby OSU Hyslop Farm station). To help with moisture retention, the scant forage that remained from year one was mowed to the soil level using a Brush Hog and seeding was done by drilling without significant tillage.

Single factor ANOVA (**Zar**. 1984) was used to detect treatment differences for forage yield, nutrient content, and 205-d adjusted calf weaning weight. Pasture was the experimental unit, replicated in paddocks. The experimental protocol was reviewed and approved by the Oregon State University Animal Care and Use Committee.

Results

In yr 1, brassica forages grew well and were ready to graze by early July. Cool season forages in the CON pastures also grew well in the unusually cool spring weather. However, the growth of the S×S (a warm-season grass) was impaired by this weather so that grazing was delayed until mid-Aug, limiting the grazing period to 14 days. By then the brassica forages were starting to mature (leaves were large and starting to yellow). The soils turned dry and rainfall was scant. The S×S plants lacked vigor and failed to grow taller than 24 in. high during the growing season. Mid-May plantings of S×S from other sites in Oregon also reported slow growth and low yields, and attributed that to cool weather after planting date. However at one site, planting was delayed until mid-June and good establishment and growth that exceeded other plantings in height and apparent yield was observed. Cool season forages grew well in the cool, wet spring.

No S×S samples tested positive for elevated nitrate levels. However, one week before the anticipated start date for grazing, one sample tested slightly positive for prussic acid. At that time, the majority of the S×S plants had a height of 18 to 20 in. Subsequent testing did not find other positive samples. As part of the outreach component of this study, six other sites around southern OR were tested for nitrates and prussic acid and none were positive. There was no apparent stress on these plants that would suggest otherwise. Cattle readily consumed the novel forages during the acclimation and experimental grazing periods, and no digestive upsets were observed. Hay provided free choice was consumed at a low rate, approximately 2 - 3 lb per day by EXT cattle. The cows and calves were eager to enter new allotments of pasture.

Average nutrient content and yield of EXT forages at various times over the grazing season are listed in Table 1. Comparison of EXT and CON for the August 19th sampling date is presented in Table 2. Forage yield of EXT tended to be lower (P = 0.056) than that of CON (2.2 and 3.4 t/ac, respectively). In contrast, CP (10.3% and 6.7%) and TDN (69% and 56%) were higher (P < 0.036 and P < 0.0001) for EXT compared to CON, respectively. Fiber components (ADF and NDF) were lower (P = 0.0001) in EXT, indicating a more digestible forage with more intake potential than the CON forage. Additionally, non fiber carbohydrate was higher (P = 0.0001) for EXT than for CON. These fiber and non fiber differences are reflected in the TDN

values. However, the higher nutrition available in the pastures did not improve calf weaning weights, which were not different (P = 0.167) between EXT and CON groups (637.2 and 679.2, respectively; Figure 1).

Table 1. Nutrient content and yield (DM basis) of extended season pasture forage at various times over the growing season[1,2]. Extended (EXT) season mixed pasture contained sorghum × Sudangrass and brassica forages.

Item	EXTENDED SEASON PASTURE			
Sample Date	July 30	Aug 19	Aug 24	Sept 14
DM (%)	20.2 (3.5)	25.7 (4.0)	28.7 (4.3)	23.2
Yield (ton/ac)	1.6 (0.2)	2.2(0.5)	2.9 (0.1)	2.6
CP (%)	12.2 (2.5)	10.3 (0.8)	8.4 (1.0)	11.4
ADF (%)	15.1 (0.9)	16.0(1.4)	17.7 (0.9)	19.2
NDF (%)	20.4 (0.8)	21.1 (3.9)	22.3 (1.6)	25.8
NFC (%)	56.8 (2.3)	58.2 (4.3)	58.8 (1.8)	52.3
TDN (%)	69 (0.6)	69 (1.5)	68 (1.0)	67
RFV	352 (13)	344 (55)	314 (25)	267

[1]Values are means with standard deviation listed in parentheses, except for the single-sample values for Sept 14.
[2]Dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), non fiber carbohydrates (NFC), total digestible nutrients (TDN), and relative feed value (RFV).

Because the grazing season in yr 1 was considerably shorter than anticipated, subsequent data on calf feedlot performance and carcass characteristics was not collected. Studies on grazing to improve calf performance should be at least 60 days (ideally 100 days) in order to show improvements (William Ocumpaugh, Texas A&M, personal communication,).

Although planting strategy was adjusted for the second experimental year, growing conditions were again less than optimal. Moisture was limiting and the soil was very hard. Some of the seeds germinated, but were unable to grow. Pasture growth was not sufficient for grazing and no additional data were obtained.

Conclusions

Establishment and growth of warm season grass and brassica mixed pastures in the late spring was severely impacted by unseasonably cold weather, and the pastures were not ready early enough to graze spring calving, cow-calf pair for the purpose of improving weights of summer-weaned calves. However, those pastures contained high quality forage that could extend the grazing season for weaned calves or other livestock into the later summer months. More studies need to be conducted to evaluate grazing opportunities for utilizing these forages in Oregon. To increase the probability of success, planting S×S and other warm season forages at a soil temperature of at least 60° on a site with predictable moisture is suggested. And, using separate fields for brassica plantings would provide more flexibility in grazing opportunities. Upon finding appropriate planting and grazing scenarios, calves should be followed into the finishing phase and packing house where average daily gain, feed efficiency, carcass quality, and yield grade can be examined. Economic data should be assembled and an analysis completed to determine any differences in unit cost of production ($/cwt of beef) between calves grazing S×S and brassica forages and other feeding regimens. This study provided a demonstration, teaching, and learning venue for faculty, students, and beef industry producers and service providers. More information has been gathered for providing recommendations on production methods and safe grazing.

Table 2. Nutrient content and yield of forages on August 19[1,2]. Treatments are extended (EXT) season mixed pasture containing sorghum × Sudangrass and brassica forages and control (CON) mixed pasture containing tall fescue, ryegrass, subterranean clover, and meadow foxtail forages.

Treatment	EXT	CON	SEM	P - level
DM (%)	25.7	54.7	1.36	0.0002
Yield (ton/ac)	2.21	3.40	0.33	0.056
CP (%)	10.3	6.7	0.84	0.0036
ADF (%)	16.0	38.1	4.95	0.0001
NDF (%)	21.1	63.7	9.60	0.0001
NFC (%)	58.2	22.1	8.14	0.0001
TDN (%)	69	56	2.86	0.0001
RFV	344	86	59.27	0.0013

[1]Values are means on a DM basis.
[2]Dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), non fiber carbohydrates (NFC), total digestible nutrients (TDN), and relative feed value (RFV).
[a,b]Values within the same column for Aug 19 EXT and CON samples with different superscripts differ (P < 0.01).
[c]Aug 19 yield for EXT and CON tended to be different (P = 0.056).

Acknowledgements

This research study was financially supported by the Oregon Beef Council and the

Byron Scott Forage Funds. Authors thank Ioka Marketing and PGG Seeds for the donation of seeds, Roger Olsen for custom farming, and student assistants Landon Grizkowski, Alvin Kuenzie, Owen White, and Caroline Odom.

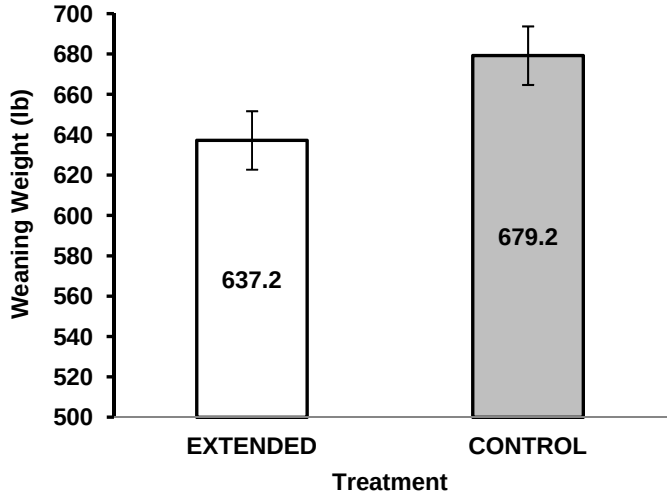

Figure 1. Calf weaning weight (205-d adjusted) for extended season and control groups was not different (*P* = 0.167). Extended treatment was mixed pastures containing sorghum × Sudangrass and brassica forages. Control was mixed pastures containing fescue, ryegrass, subterranean clover, and meadow foxtail.

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Oregon State University

BEEF069

Beef Cattle Sciences

Oregon Beef Council Report

The Affect of Female Reproductive Hormones on Cells of the Immune System in Cattle[1]

Adrienne M. Lulay[2], Matthew J. Cannon[2] and Alfred R. Menino, Jr[2]

Synopsis

White blood cells (WBC) in plasma vary by stage of the estrous cycle and can be increased by administration of the uterine hormone prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$).

Summary

The objectives of this research were to evaluate changes in total WBC, neutrophils and lymphocytes by stage of the estrous cycle and after injection with the natural uterine hormone $PGF_{2\alpha}$ (Lutalyse) or a synthetic analog, cloprostenol sodium (Estrumate). In the first experiment, blood was collected from cows on Days 0 (Day 0 = onset of estrus), 7, 14 and 21 of the estrous cycle and evaluated for total WBC, neutrophils and lymphocytes. Total WBC and lymphocytes did not differ ($P>0.10$) by day of the estrous cycle but neutrophils were greatest ($P<0.05$) on Day 14. In the second experiment, cows were injected with a single dose of Lutalyse or saline (Control) and blood was collected at 0, 1, 4 and 8 h post-injection. Lutalyse increased ($P<0.05$) total WBC and neutrophils 4 and 8 h post-injection but had no effect ($P>0.10$) on lymphocytes. In the third experiment, cows were injected with a single dose of Lutalyse, Estrumate or saline (Control) and blood was collected at 0, 1, 2, 4, 8 and 16 h post-injection. Lutalyse increased ($P<0.05$) total WBC 2 and 4 h post-injection. More neutrophils were observed in Lutalyse-treated cows but no significant differences were detected. Both prostaglandins increased lymphocyte numbers 16 h post-injection but only Lutalyse provided a significant response. These results demonstrate that WBC, especially neutrophils, vary by stage of the estrous cycle and a single dose of $PGF_{2\alpha}$ can increase neutrophils and lymphocytes in the circulation.

Introduction

Incidences of uterine infections in dairy cattle are high in the early postpartum period. Dairy cows with uterine infections are at risk for prolonged periods of days open and multiple services before becoming pregnant. Impairment of fertility during and following uterine infection appears to involve disruption of normal physiological events at the level of the uterus, ovary and the hypothalamic/pituitary axis. At the level of the ovary, uterine infection delays the resumption of ovarian cyclicity and prolongs the luteal phase after first postpartum ovulation (Mateus et al., 2003). Typically, animals are most susceptible to uterine infection when circulating concentrations of progesterone are elevated, such as during the luteal phase of the estrous cycle (Seals et al., 2002; Lewis, 2003). It is believed that contamination of the uterus with pathogenic bacteria occurs at or shortly following parturition, but that bacteria do not thrive until circulating concentrations of progesterone are

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Department of Animal Sciences, Oregon State University, Corvallis, OR 97331-6702 Email: alfred.r.menino@oregonstate.edu.

elevated after the first ovulation postpartum. With this in mind, administration of a luteolytic dose of $PGF_{2\alpha}$ or one of its analogs, to cause luteal regression and remove the progesterone source, has become the current therapy of choice for most diagnosed uterine infections (Lewis, 1997). Although there is a great deal of speculation as to the reason for the effectiveness of exogenous $PGF_{2\alpha}$ as a treatment for uterine infections, the mechanism of action remains unclear. It has been established that progesterone inhibits proliferation of lymphocytes in the cow (Low and Hansen, 1988), but neutrophils, rather than lymphocytes, are the most important immune cell involved in clearance of uterine bacterial infections in dairy cattle (Cai et al., 1994; Dhaliwal et al., 2001). Neutrophil function seems to be mediated by reproductive hormones and good uterine health is related to properly functioning neutrophils. Identifying the mechanism whereby the reproductive hormones affect cells of the immune system may provide insights into maintaining uterine health and improving conception rate. This information may also provide the added benefit of developing treatments that would reduce antibiotic use in dairy herds. Therefore, the objectives of this research were to evaluate changes in WBC numbers, particularly neutrophils and lymphocytes, by stage of the estrous cycle and after injection with the natural uterine hormone $PGF_{2\alpha}$ or a synthetic analog, cloprostenol sodium.

Materials and Methods

Animals

A total of 24 cows at the Oregon State University Dairy Research Center were used for this research. All procedures conducted with animals were approved by the Oregon State University Institutional Animal Care and Use Committee.

Experiment 1

The objective of the first experiment was to evaluate changes in numbers of total WBC, neutrophils and lymphocytes by stage of the estrous cycle. Blood samples (10 ml) were collected by coccygeal venipuncture into Vacutainer tubes containing sodium heparin as the anti-coagulant from seven cows on Days 0 (Day 0 = onset of estrus), 7, 14 and 21 of the estrous cycle. Complete Blood Counts (CBC) were performed on all samples by the Oregon State University Veterinary Diagnostic Laboratory.

Experiment 2

The objective of the second experiment was to evaluate changes in numbers of total WBC, neutrophils and lymphocytes following injection with the natural uterine hormone $PGF_{2\alpha}$ (Lutalyse; Pfizer, New York, NY). Eight cows were randomly assigned to one of two treatments, Control or Lutalyse (four cows per treatment). Control cows were injected with 5 ml of physiological saline and Lutalyse cows were injected with 5 ml of Lutalyse (25 mg). Blood (10 ml) was collected at 0, 1, 4 and 8 h post-injection and CBC were performed as described as described in Experiment 1.

Experiment 3

The objective of the third experiment was to evaluate changes in numbers of total WBC, neutrophils and lymphocytes following injection with the natural uterine hormone $PGF_{2\alpha}$ (Lutalyse) or a synthetic $PGF_{2\alpha}$ analog, cloprostenol sodium (Estrumate; Merck and Co., Inc., Summit, NJ). Nine cows were randomly assigned to one of three treatments, Control, Lutalyse or Estrumate (three cows per treatment). Control, Lutalyse and Estrumate cows were injected with 5 ml of physiological saline, 5 ml of Lutalyse (25 mg) or 2 ml of Estrumate (500 μg), respectively. Blood (10 ml) was collected at 0, 1, 2, 4, 8 and 16 h post-injection and CBC were performed as described as described in Experiment 1.

Statistical analyses

In Experiment 1, differences in numbers of total WBC, neutrophils and lymphocytes were analyzed by one-way analysis of variance (ANOVA) where day of the estrous cycle was the source of variation. In Experiments 2 and 3, differences in numbers of total WBC, neutrophils and lymphocytes were analyzed by repeated measures ANOVA. For Experiments 2 and 3, sources of variation in the ANOVA were treatment (Control and Lutalyse and Control, Lutalyse and Estrumate, respectively), time and the treatment x time interaction. If significant effects were observed in the ANOVA, differences between means were evaluated by Fisher's least significant differences procedures. All analyses were performed using the NCSS statistical software program (Number Cruncher Statistical System; 2000, Jerry Hintze, Kaysville, UT).

Results

Experiment 1

Numbers of total WBC and lymphocytes did not differ (P>0.10) by day of the estrous cycle (Figure 1). Although numbers of neutrophils were similar (P>0.10) on Days 0, 7 and 21, a significant increase was observed on Day 14 of the cycle (Figure 1).

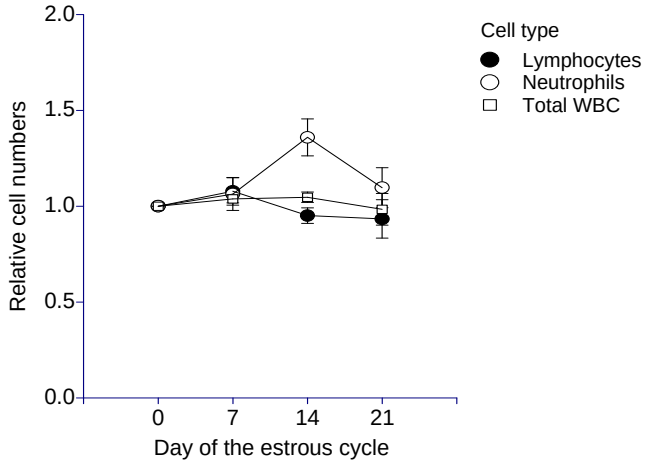

Figure 1. Changes in total white blood cells (WBC), neutrophils and lymphocytes over the estrous cycle in the cow.

Experiment 2

Total WBC over the 8 h sampling period were unchanged (P>0.10) in Control cows injected with saline (Figure 2). In cows injected with Lutalyse, no changes (P>0.10) in total WBC were observed within 1 h but significant increases were observed at 4 and 8 h post-injection (Figure 2). As expected from the total WBC data, numbers of neutrophils did not change (P>0.10) after injection with saline (Figure 3). Neutrophils followed a similar pattern as total WBC following injection with Lutalyse (Figure 3). Numbers of neutrophils were unchanged (P>0.10) at 1 h but increased (P<0.05) dramatically at 4 h and remained elevated through 8 h after injection of Lutalyse (Figure 3). Lutalyse exerted no effect (P>0.10) on lymphocyte populations and numbers were similar (P>0.10) to Control cows within the 8-h sampling period (Figure 4).

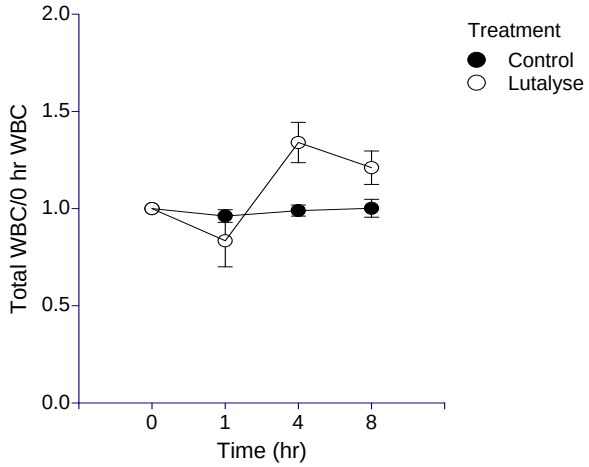

Figure 2. Changes in total white blood cells (WBC) after injection of Lutalyse or saline (Control).

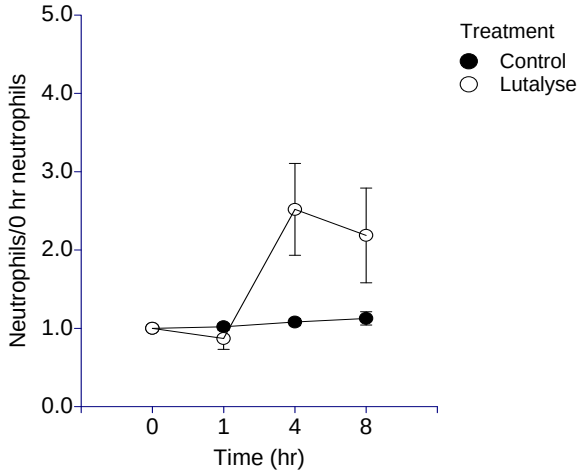

Figure 3. Changes in neutrophils following injection of Lutalyse or saline (Control).

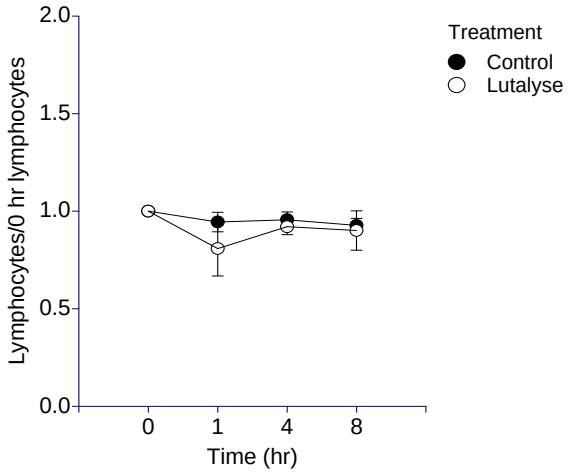

Figure 4. Changes in lymphocytes after injection of Lutalyse or saline (Control).

Experiment 3

No differences (P>0.10) in total WBC were observed in Control cows over the 16-h sampling period (Figure 5). In Lutalyse cows, total WBC increased (P<0.05) at 2 and 4 h then returned to near 0-h values at 8 and 16 h post-injection (Figure 5). Interestingly, despite the changes in total WBC observed with Lutalyse, no differences (P>0.10) in total WBC were observed in cows injected with Estrumate, the $PGF_{2\alpha}$ synthetic analog (Figure 5).

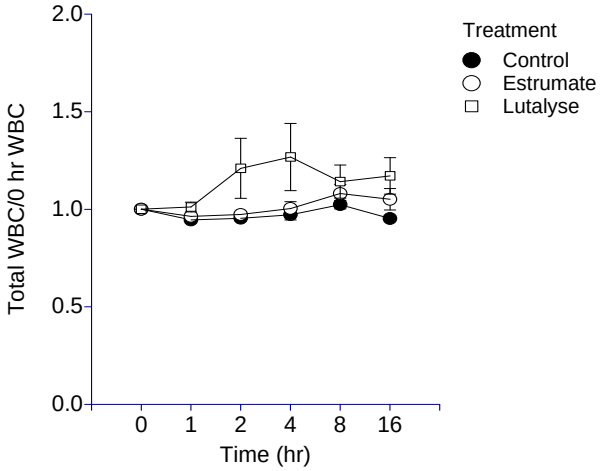

Figure 5. Changes in total white blood cells (WBC) after injection of Estrumate, Lutalyse or saline (Control).

Numbers of neutrophils observed over the 16-h sampling period did not differ (P>0.10) among cows injected with saline, Lutalyse or Estrumate (Figure 6). Although more neutrophils were observed in Lutalyse-treated cows, no significant differences were detected. Neutrophil counts in this experiment were fraught with significant variation between animals, as evidenced by the large standard error bars, which no doubt contributed to the lack of statistical significance in the analysis (Figure 6).

Numbers of lymphocytes were similar (P>0.10) among Control, Lutalyse or Estrumate cows during the first 8 h of sampling (Figure 7). However, both prostaglandins increased lymphocyte numbers 16 h post-injection with Lutalyse inducing a significantly greater response compared to saline (Figure 7).

These results confirm WBC numbers, especially neutrophils, vary by stage of the estrous cycle and this effect is most likely due to the reproductive hormones dominating the cows plasma when blood was drawn. Interesting effects on neutrophils, and to some extent, lymphocytes, were observed following a single injection of Lutalyse.

Lutalyse treatment likely increased total WBC by increasing neutrophils. This response was reasonably rapid and occurred within 2 h of injection. The response, however, did not appear to be sustained beyond 8 h post-injection. Interestingly a similar, although delayed, response was observed with lymphocytes where an increase was not observed until 16 h post-injection with either prostaglandin. Why Estrumate did not induce responses in neutrophils more closely to Lutalyse is not known. Cloprostenol sodium is a synthetic analog of $PGF_{2\alpha}$ with greater biological activity. However, the doses administered were the prescribed luteolytic doses and would be expected to share similar biological potency. Presumably the prostaglandins would interact with specific receptors on their target cells to induce the observed responses and it may be that cloprostenol sodium does not engage the $PGF_{2\alpha}$ receptor in the same fashion as the native hormone.

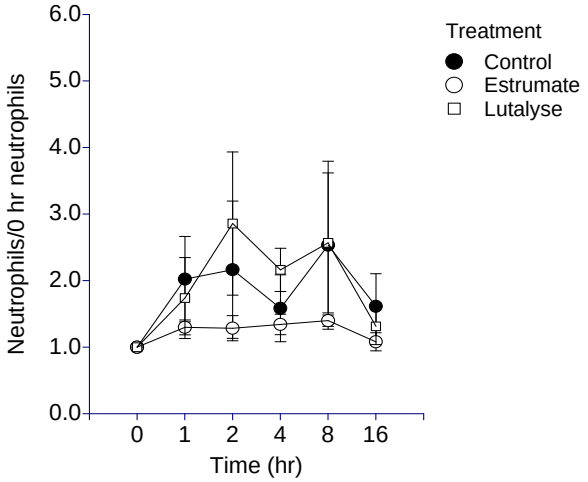

Figure 6. Changes in neutrophils following injection of Estrumate, Lutalyse or saline (Control).

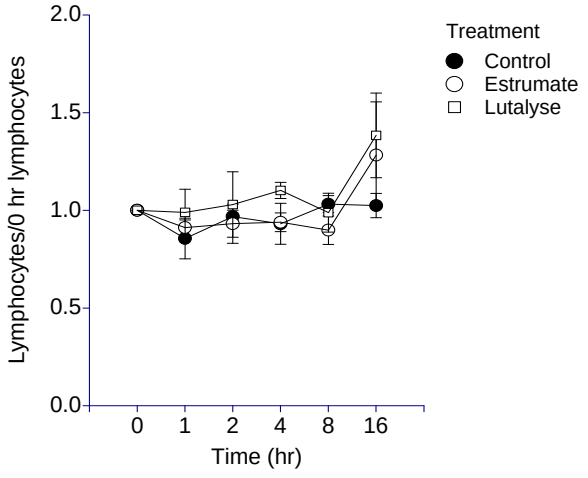

Figure 7. Changes in lymphocytes after injection of Estrumate, Lutalyse or saline (Control).

Considerable speculation exists as to how $PGF_{2\alpha}$ works to clear uterine infections. One popular notion is that $PGF_{2\alpha}$ exerts a purgative effect on the uterus by causing uterine contractions. However, in an equine model, $PGF_{2\alpha}$-stimulated contractions reduced the volume of uterine fluid present during an infection without eliminating the bacteria (Nikolakopoulos and Watson, 1999). It has also been hypothesized that $PGF_{2\alpha}$ resolves uterine infections through its luteolytic activity because it causes regression of the corpus luteum, thereby reducing circulating progesterone concentrations. However, $PGF_{2\alpha}$ administration resulted in clearance of bacterial infections even when circulating progesterone concentrations were maintained at luteal phase or greater concentrations (Del Vecchio et al., 1994; Lewis, 2003). Results from the current experiments strongly suggest $PGF_{2\alpha}$ exerts direct effects on neutrophil and lymphocyte proliferation; a rapid short-term response on neutrophils and a delayed response on lymphocytes. This mechanism may be how $PGF_{2\alpha}$ functions to clear uterine infections.

Conclusions

Numbers of WBC, specifically neutrophils, vary be day of the estrous cycle, presumably due to changes in plasma concentrations of the reproductive hormones. Neutrophil and, to some extent, lymphocyte proliferation can be stimulated by a single injection of $PGF_{2\alpha}$. The effects on neutrophil and lymphocyte populations may be the mechanism by which $PGF_{2\alpha}$ clears uterine infections.

Acknowledgements

This research was generously supported by the Oregon Beef Council and the Oregon Agricultural Experiment Station.

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Oregon State University

BEEF068

Beef Cattle Sciences

Oregon Beef Council Report

Can Prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) be Used during the Postpartum Anestrus Period to Improve Uterine Health and Reproductive Efficiency?[1]

Adrienne M. Lulay[2], Matthew J. Cannon[2] and Alfred R. Menino, Jr[2]

Synopsis

Administration of $PGF_{2\alpha}$ (Lutalyse) to cows increases uterine neutrophils, a subset of white blood cells, and decreases uterine pathogenic bacteria which may reduce the incidence of infection thereby decreasing days open and improving fertility.

Summary

The objective of this research was to determine whether administration of Lutalyse in the early postpartum period has a positive impact on uterine health and reproductive efficiency. Cows calving at the Oregon State University Dairy Research Center were divided into four treatments (10 cows per treatment). Treatments consisted of two injections (im) of: 1) saline (5 ml) on Days 0 and 14 postpartum (where Day 0 = day of calving), 2) saline (5 ml) on Days 14 and 28 postpartum, 3) Lutalyse (25 mg/5 ml) on Days 0 and 14 postpartum and 4) Lutalyse (25 mg/5 ml) on Days 14 and 28 postpartum. For all treatments, on the day of the second injection (Day 14 or 28; Time 0) and 24 h after the second injection (Time 24), the cow's uterus was sampled for uterine bacterial load using a double guarded swab. The swab was placed into a tube containing 10 ml of DPBS and transported to the laboratory within 1 hour of collection for bacterial culture. To provide an assessment of the uterine neutrophil population, a guarded CytoBrush was passed into the uterus immediately following the uterine swabbing at Times 0 and 24. A cell smear was prepared from the CytoBrush and neutrophils were counted. Blood samples were drawn at Times 0 and 24 to validate plasma progesterone concentrations. All cows on experiment were evaluated daily for evidence of uterine infections, e.g., vaginal discharge, fever, etc.

Introduction

Uterine infections during the period after calving, or the postpartum period, are a significant problem to dairy producers. Dairy cows are particularly susceptible to develop uterine infections because of conditions associated with housing and production. Bacterial infections, such as endometritis, metritis and pyometra, occurring within 28 days postpartum affect 10 to 50% of cows annually. The majority of these infections go undiagnosed and untreated. Fertility is reduced in cows with uterine infections because of abnormal reproductive cycles, lower conception rates (20% lower than healthy cows), and longer days open (an average of 30 days longer than healthy cows). The cost of days open beyond 100 days has been estimated to be as much as $5.40/day for the dairy cow. Uterine infections in dairy cattle can therefore cost producers as much as $162 ($5.40/day x 30

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Department of Animal Sciences, Oregon State University, Corvallis, OR 97331-6702 Email: alfred.r.menino@oregonstate.edu.

days) per affected cow. Depending on the uterine infection incidence one uses to calculate cost to Oregon dairy producers on a state-wide basis, income loss due to uterine infections is estimated to range between $2 million (125,000 Oregon dairy cows x 10% x $162/infected cow) to as much as $10.1 million (125,000 cows x 50% x $162/cow) annually.

During pregnancy, the uterus is a sterile environment, but during calving and the early postpartum period, bacteria from the cow's environment can colonize the uterus, causing infection (Singh et al., 2008). Fertility is impaired in infected cows due to disruption of normal physiological events in the uterus and ovary. It is known that susceptibility of the uterus to bacterial infection is higher when the ovarian hormone progesterone is high, and that susceptibility is lower when the ovarian hormone estrogen and the uterine hormone $PGF_{2\alpha}$ are high (Williams et al., 2007; Kaneko and Kawakami, 2009). Significant research effort has also been directed towards studying the pathogenic microorganisms that cause uterine infections and the effects these microorganisms have on impairment of fertility in cattle. However, despite this research, preventative practices and new treatment strategies to alleviate the problem have not been developed, and the incidence of uterine infection has not changed significantly in cattle over the previous 30 years. New knowledge in this area is a necessary first step towards development of new and practical methods for preventing uterine infections and novel therapeutic regimes not requiring antibiotics for treatment of uterine infections in cattle. Therefore, the objective of this research was to evaluate the effects of a Lutalyse injection protocol on uterine bacterial load and neutrophil numbers in postpartum dairy cows.

Materials and Methods

Animals

Forty postpartum cows at the Oregon State University Dairy Research Center were randomly assigned to four treatments (10 cows per treatment). Treatments consisted of two injections (im) of: 1) saline (5 ml) on Days 0 and 14 postpartum (where Day 0 = day of calving), 2) saline (5 ml) on Days 14 and 28 postpartum, 3) Lutalyse (Pfizer, New York, NY; 25 mg/5 ml) on Days 0 and 14 postpartum and 4) Lutalyse (25 mg/5 ml) on Days 14 and 28 postpartum. All work conducted with animals in this research was approved by the Oregon State University Institutional Animal Care and Use Committee.

Sampling for uterine bacterial loads

For all treatments, on the day of the second injection (Day 14 or 28), the cow's uterus was sampled for uterine bacterial load using a double guarded swab (Time 0). The swab was placed into a tube containing 10 ml of Dulbecco's phosphate buffered saline (DPBS) and transported to the laboratory within 1 h of collection for culture. Twenty-four hours after the first swab, a second uterine swab was collected (Time 24), placed into a tube containing 10 ml of DPBS and transported to the laboratory within 1 h of collection for culture.

Sampling to assess neutrophil populations

To provide an assessment of the uterine neutrophil population, a subset of white blood cells, a guarded CytoBrush was passed into the uterus immediately following the uterine swabbing at Times 0 and 24. The CytoBrush was rolled onto a microscope slide to create a cell smear. The smear was stained using the Wright/Giemsa staining procedure for assessing white blood cell populations and neutrophils were counted. Cows received their second injection following completion of the uterine swabbing and CytoBrush procedures at Time 0.

Progesterone analysis

Blood samples (10 ml) were drawn by coccygeal venipuncture at Times 0 and 24 to validate plasma progesterone concentrations. Blood was collected into Vacutainer tubes containing sodium heparin as the anti-coagulant. Plasma was separated by centrifugation at 1000xg for 10 min at 4°C and stored at -20°C until assayed for progesterone. Progesterone was assayed using kits purchased from CALBIOTECH (Spring Valley, CA).

Bacterial cultures

Serial dilutions using DPBS as the diluting fluid (0, 1/10 and 1/100) were made from the original uterine sample and 100 µl was plated onto each side of a Blood Agar/MacConkey's Agar bacteriological culture biplate. Biplates were incubated for 1 h at room temperature, transferred to a 37°C incubator, turned over and cultured with the lid side down on the incubator tray for 24 h. Following incubation at 37°C bacterial colonies growing on each agar type were counted. Colony counts on the blood agar side provided the total

number of pathogenic bacteria and counts from the MacConkey's agar side, a selective medium, provided the number of *E. coli.*

Observational data

All cows on experiment were evaluated daily for evidence of uterine infections, e.g., vaginal discharge, fever, etc.

Statistical analyses

Differences between Times 0 and 24 in the total numbers of bacteria, *E. coli* and neutrophils and plasma progesterone concentrations were analyzed by analysis of variance (ANOVA) for a 2 x 2 factorial design. Sources of variation in the ANOVA included treatment regimen (Days 0 and 14, Days 14 and 28), injection (saline, Lutalyse) and the treatment x injection interaction. If significant effects were observed in the ANOVA, differences between means were evaluated by Fisher's least significant differences procedures. Observational data or numbers of cows observed with uterine infections were analyzed for differences due to treatment using Chi-square procedures. All analyses were performed using the NCSS statistical software program (Number Cruncher Statistical System; 2000, Jerry Hintze, Kaysville, UT).

Results

Work on this project is still ongoing. Currently, numbers of neutrophils, total pathogenic bacteria and *E. coli*, plasma progesterone concentrations and health and reproductive data have been collected on 4, 2, 5 and 5 cows from treatments Days 0 and 14 saline, Days 14 and 28 saline, Days 0 and 14 Lutalyse and Days 14 and 28 Lutalyse, respectively. Preliminary analysis of total uterine bacterial load suggests injecting Lutalyse on Days 14 and 28 postpartum provides the greatest reduction in pathogenic bacteria (Figure 1). Injections, uterine bacterial swabs and cultures, Cytobrush smears, progesterone analysis and collecting observational data for the cows remaining in each of the four treatments is underway.

Conclusions

If Lutalyse treatment is indeed effective in increasing uterine neutrophils and reducing uterine bacterial loads and infections then this treatment regimen can be readily implemented with relatively little cost. Lutalyse is commonly used in dairy operations to synchronize estrous cycles for artificial insemination and a single dose costs approximately $2.85. Therefore, treating cows with Lutalyse early in the postpartum period could provide an inexpensive method not requiring antibiotics for preventing uterine infections in cattle.

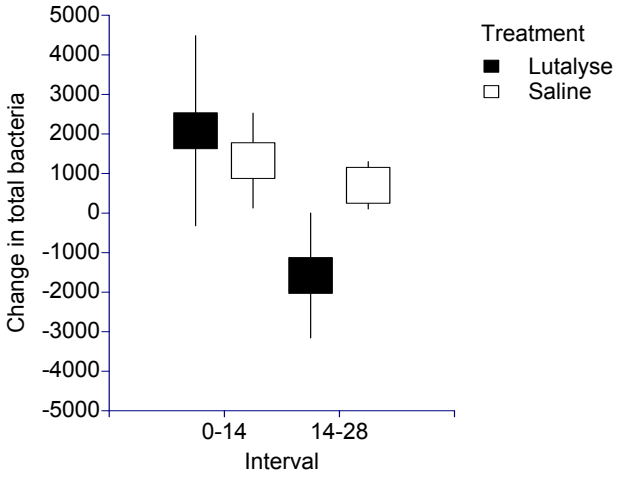

Figure 1. Changes in total pathogenic uterine bacterial load in cows treated with saline or Lutalyse on Days 0 and 14 or 14 and 28 postpartum

Acknowledgements

This research was generously supported by the Oregon Beef Council and the Oregon Agricultural Experiment Station.

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Oregon State University

BEEF066

Beef Cattle Sciences

Oregon Beef Council Report

Development of a Diagnostic Test for Pregnancy Detection in Cattle[1]

Ruben Mendoza[2] and Alfred R. Menino, Jr[2]

Synopsis

Development and implementation of an assay for cattle pregnancy detection would benefit commercial cattle producers by eliminating the cost associated with maintaining non-pregnant cows.

Summary

The objective of this research was to adapt a kit that measures the plasma protein plasminogen activator inhibitor-2 (PAI-2) in humans for quantifying PAI-2 in cow plasma during pregnancy. In pregnant woman, plasma PAI-2 concentrations increase as gestation proceeds. Our laboratory has detected PAI-2 production by Day 14 cow embryos and this protein may serve as an indicator of pregnancy in cattle providing detectable quantities can be measured in the blood. Plasminogen activator inhibitor-2 concentrations during pregnancy were quantified in cow plasma and increased as gestation advanced. If plasma PAI-2 concentrations can be reliably measured during gestation in cattle, the long term goal is to develop a "dip-stick" type assay for pregnancy diagnosis similar to the "over-the-counter" products available for pregnancy detection in humans.

Introduction

Beef and dairy cattle producers are limited in the selection of approaches that can be used for pregnancy detection. Currently, there is no commercially available diagnostic kit for pregnancy detection in cattle that is comparable to the "over-the-counter" pregnancy tests available to humans. A diagnostic kit for progesterone is available that measures the relative amount of progesterone in the blood or milk. Progesterone is a hormone produced by the cow's ovary and remains high during pregnancy. However, this kit has limited application because approximately 75% of the time a non-pregnant cow will have progesterone levels indistinguishable from a pregnant cow. The BioPRYN (Pregnancy Ruminant Yes/No) procedure detects a pregnancy-specific protein in ruminant plasma known as pregnancy-specific protein B (PSPB) which is produced by the placenta. One limitation of BioPRYN is that the procedure requires the blood samples to be shipped to a laboratory for analysis. Although accuracy of detection of PSPB is fairly high and reports can be available in approximately a day, this assay protocol eliminates an "on the farm" test. Another limitation of BioPRYN is that it can be only used for early pregnancy detection (≈ Day 30 of pregnancy) in heifers. Cows that have calved will retain PSPB production until Day 90 of pregnancy thereby eliminating the availability of an early pregnancy test for the majority of the herd. Other techniques available to producers to detect pregnancy in cattle include examination of the reproductive tract via rectal palpation or ultrasonography. A veterinarian is usually called for the rectal palpation hence additional

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Department of Animal Sciences, Oregon State University, Corvallis, OR 97331-6702 Email: alfred.r.menino@oregonstate.edu.

include examination of the reproductive tract via rectal palpation or ultrasonography. A veterinarian is usually called for the rectal palpation hence additional cost is incurred for the visit. Although detection of pregnancy by ultrasound approaches an acceptable percentage of correct diagnoses as early as 20 days after breeding, this procedure also requires a veterinary call and, this time, with specialized instrumentation.

The major advantage in accurate early pregnancy diagnosis is the culling of cows either artificially inseminated or exposed to bulls during the breeding season that have not become pregnant. Non-pregnant cows need to be eliminated from the herd as quickly as possible after the breeding season to avoid the expense of maintaining non-productive females. One estimate of the value involved in eliminating maintenance costs of non-pregnant cows is that for every 10% improvement in pregnancy rate there is a financial savings of 14% per pregnancy (Broadbent et al., 1991). This is of particular relevance to beef cattle producers who depend on returns from the calf crop. The ideal diagnostic kit would be one that producers could purchase cheaply and use on the farm without veterinary assistance.

For several years, our laboratory has been researching the protease plasminogen activator (PA) which is produced by cow embryos as early as Day 8 of pregnancy (Kaaekuahiwi and Menino, 1990; Singleton and Menino, 2005). Cow embryos also produce inhibitors of PA (PAI) that appear by Days 12-14 of pregnancy (Dyk and Menino, 1991). Interestingly, in humans, the placenta produces a specific pregnancy-associated PAI (PAI-2) that can be detected in the blood and increases as pregnancy progresses (Lecander and Astedt, 1986). Therefore, two questions emerged for the cow embryo PAI: 1) does the PAI produced by cow embryos appear in the blood during pregnancy, and if, yes, when, and 2) can the cow embryo PAI be distinguished from other PAIs normally found in the cow's blood? If the embryo PAI appears in the cow's blood before 21 days after breeding and it can be readily distinguished from other blood PAIs, then it would be feasible to develop a diagnostic kit for pregnancy detection in cattle. Western blotting was initially conducted to identify the type of PAI produced by cattle embryos. Culture medium and tissue extracts of Day 13-14 cattle embryos were probed with antisera to human PAI-1 and PAI-2. PAI-1 was observed in the culture medium and PAI-2 was detected in both culture medium and tissue extracts from Day 13-14 embryos.

Validating the identities of the PAI produced by the cow embryo allowed us to decide which PAI to pursue in developing a pregnancy test. Plasminogen activator inhibitor-1 is a normal constituent of plasma hence it would be least applicable of the two unless levels changed dramatically during pregnancy. Plasminogen activator inhibitor-1 concentrations change little in humans during pregnancy but no information of this nature is available in the cow. Plasminogen activator inhibitor-2 concentrations in cow plasma are near the detection limits of current assays however concentrations in humans increase during pregnancy. In a preliminary experiment using a kit from American Diagnostica, Inc. that measures PAI-2 in humans, we were able to detect PAI-2 in plasma from pregnant cows but not from non-pregnant cows. For these reasons, we proposed to pursue detection of PAI-2 in cow plasma for pregnancy diagnosis. Therefore, the objective of this research was to develop a diagnostic assay for pregnancy detection in cattle based on the detection of PAI-2 in plasma.

Materials and Methods

To quantify changes in PAI-2 during pregnancy in cattle, blood was recovered by tail venipuncture from cows maintained at the Oregon State University Dairy Research Center at 10, 20, 30, 45, 60, 90, 120, 150, 180, 210, and 240 after breeding (3 cows on each sample day). Pregnancy was confirmed by rectal palpation of the reproductive tract starting at Day 45. Blood was also drawn from a control group of non-pregnant cows at 0 (follicular phase) and 12 (luteal phase) days after onset of heat (3 cows on each sample day). Plasma was collected by centrifugation and frozen at -20°C until assayed for PAI-2. Plasminogen activator inhibitor-2 concentrations in cow plasma were quantified using a kit marketed by American Diagnostica, Inc. for quantification of PAI-2 in human plasma as per the manufacturer's instructions.

Differences in plasma PAI-2 concentrations over days of gestation were determined by one-way analysis of variance (ANOVA). All analyses were performed using the NCSS statistical software program (Number Cruncher Statistical System; 2000, Jerry Hintze, Kaysville, UT).

Results

Plasminogen activator inhibitor-2 concentrations were quantified in plasma recovered from cows on Days 0, 60, 90, 120, 150, 180 and 210

days of gestation (Figure 1). Although plasma PAI-2 concentrations increased as days of gestation in the cow increased, the amplitude of increase was much less dramatic than observed during human pregnancy (Lecander and Astedt, 1986). Overall performance of the assay for quantifying cow PAI-2 was satisfactory however some between sample variability was encountered. During our attempts to modify certain aspects of the assay protocol to improve its precision, the vendor, American Diagnostica, Inc., discontinued production of the kit.

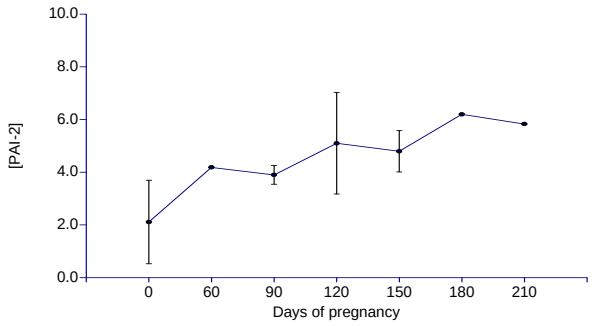

Figure 1. Changes in plasma plasminogen activator inhibitor-2 (PAI-2) during gestation in the cow.

In order to pursue this project, an assay had to be created or a new assay identified and validated to measure cow PAI-2. The assay marketed by American Diagnostica, Inc. was an enzyme-linked immunosorbent assay (ELISA) that used two antibodies to detect human PAI-2. The antibodies in this assay also cross-reacted with cow PAI-2 which was why it could be measured in the cow plasma. Our laboratory has experience in developing and conducting ELISAs hence two strategies were conducted simultaneously; develop direct and indirect ELISAs for measuring cow PAI-2. However, antibodies that recognize PAI-2 are only available for humans, rats, mice, guinea pigs and rabbits and an antibody that specifically identifies cow PAI-2 is not yet available. Therefore, our laboratory started on the path of searching for and testing antibodies that would cross-react with the cow PAI-2. Although we have been successful in developing the ELISAs, the combinations of antibodies we have tested were not successful in detecting cow PAI-2.

Assays for PAI-2, unlike PAI-1, are scarce. Currently, only two vendors, both international, distribute kits. Our laboratory has evaluated kits designed for detection of PAI-2 in humans, rats, mice and rabbits from one vendor and these kits have not been successful in identifying the cow PAI-2.

Our laboratory is continuing on both paths; testing antibodies in the ELISAs to identify cross-reacting antibodies and evaluating kits from the alternative international vendor. Our laboratory will also repeat the western blotting experiments we conducted several years ago that first identified PAI-2 production by the early cow embryo in an attempt to secure suitable cross-reacting antibodies.

Conclusions

Early experiments using a kit designed for measuring human plasma PAI-2 were successful in quantifying an increase in plasma PAI-2 concentrations as gestation advanced in cattle. Although this kit has been discontinued and a suitable replacement has not been found, work is continuing to develop a reliable assay to measure PAI-2 in cow plasma.

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This research was generously supported by the Oregon Beef Council and the Oregon Agricultural Experiment Station.

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Oregon State University

BEEF067

Beef Cattle Sciences

Oregon Beef Council Report

Application of a Plasminogen Activator Assay to Assess Bovine Embryo Viability during Embryo Transfer Procedures[1]

Ruben Mendoza[2], Katie Hayes[2] and Alfred R. Menino, Jr[2]

Synopsis

Development of the proposed technique for assessing the likelihood of embryo survival following an embryo transfer would benefit commercial cattle producers by eliminating the cost associated with transferring embryos with reduced success of pregnancy establishment and maintaining non-pregnant recipients.

Summary

The objective of this research was to determine if the amount of plasminogen activator (PA) produced by cow embryos was related to success in establishing a pregnancy. A preliminary experiment demonstrated that mean PA production was similar (P>0.10) for embryos establishing a pregnancy compared to embryos failing to generate a pregnancy (1.3±0.5 vs. 4.6±2.8 mIU/ml/h, respectively). However, when a threshold level for PA production of 0.3 mIU/ml/h was established, 32% (7/22) of embryos with PA production above threshold compared to only 9% (1/11) of embryos with PA production equal to or below threshold developed into pregnancies. If a significant relationship is identified between PA production and success of pregnancy establishment, an additional marker would be available to grade embryos. Producers would be able to select embryos based on the amount of PA produced to obtain greater conception rates during transfer.

Introduction

A method to accurately determine viability among embryos and provide a reasonable prediction of pregnancy rate in embryo transfer is as yet unavailable. When faced with the decision as to which embryos in a flush should be transferred to recipients and will result in the greatest number of offspring, the operator often relies on gross observations. These observations, which include such features as degenerating or irregular sized cells (blastomeres), granulation and vesicles, are useful and fairly accurate in determining embryos of exceptionally poor quality but are of little use in differentiating within the range of viability. A method for accurately assessing embryo viability prior to transfer to a recipient would afford some measure of the embryo's ability to sustain a pregnancy (Sreenan and Diskin, 1987). Such a system would provide for determining embryo quality and predicting the success of pregnancy establishment. Grading schemes based on these morphologic aspects of embryos are fairly accurate in predicting pregnancy rates between embryos which are several grades apart. The morphologic scoring system, however, is not that accurate for embryos which either grade closely or are in the fair,

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Department of Animal Sciences, Oregon State University, Corvallis, OR 97331-6702 Email: alfred.r.menino@oregonstate.edu.

good and excellent grades. Attempts at grading embryos on the basis of variation in gross morphology and then evaluating pregnancy rates in females receiving various grades were conducted by Shea (1981). In this particular work, three grades of bovine embryos were defined. Grade 2 embryos were characterized by uneven blastomere size, extensive blastomere extrusion and evidence of membrane rupture. Grade 3 embryos were designated as having an average appearance and Grade 4 embryos were perfectly symmetrical, evenly granulated, lacking in blastomere extrusion and possessed no deformations in the zona pellucida. Pregnancy rates for grades 4, 3 and 2 embryos were 71, 56 and 44%, respectively. Lindner and Wright (1983) devised an alternative grading scheme based on the gross morphology of bovine embryos that was comprised of four ranks. Pregnancy rates for excellent, good, fair and poor embryos were 45, 44, 27 and 20%, respectively. Studies such as these illustrate that despite the apparent range in morphology encountered in evaluating embryos prior to transfer, pregnancy can still be established in recipient females with embryos of supposedly inferior morphology.

Our laboratory has been researching production of the protease plasminogen activator (PA) by cultured cattle embryos since 1987 (Menino and Williams, 1987). Plasminogen activator secretion is undetectable until the blastocyst stage, increases during blastocoelic expansion and initiation of hatching and remains elevated throughout and after loss of the zona pellucida. High levels of PA production were associated with embryos undergoing vigorous development whereas low levels of PA were produced by poorly developing embryos (Kaaekuahiwi and Menino, 1989). The assay used in these studies is a caseinolytic agar gel assay which is simple yet sensitive. Plasminogen activator has many roles in the early embryo and our laboratory has recently observed that this protease is involved in the establishment of the extraembryonic endoderm which is a component of the fetal membranes in the cow fetus (Singleton and Menino, 2005). Based on these observations, PA secretion by cow embryos may be used as an accurate indicator of embryo viability and, potentially, pregnancy establishment. Therefore, the objective of the proposed research was to determine if PA production by an embryo is correlated with its ability to sustain a pregnancy.

Materials and Methods

In a preliminary experiment, embryos were collected nonsurgically from superovulated and artificially inseminated beef heifers 7 d after estrus onset. Embryos were evaluated for morphology and stage of development (Lindner and Wright, 1983) and cultured for 21-22 h in 25-µl microdrops (one embryo/microdrop) of Ham's F-12 with 15 mg/ml bovine serum albumin under paraffin oil in a humidified atmosphere of 5% CO_2, 5% O_2 and 90% N_2 at 39°C. At the end of the culture period, each embryo was again graded for morphology and quality and assigned one of the following numerical scores as described by Lindner and Wright (1983): excellent (4), good (3), fair (2) or poor (1). Embryos were aspirated into 0.25-ml polyvinyl chloride straws and transferred to recipients within 1 h of recovery from culture. A 15-µl aliquot of culture medium was recovered and frozen at -20°C until assayed for PA. Plasminogen activator concentrations in the culture medium were determined using the caseinolytic assay described by Kaaekuahiwi and Menino (1990) for cow embryos with urokinase as the standard. Recipients were diagnosed for pregnancy by ultrasonography at 30 to35 d after transfer.

Differences in PA production and quality scores between embryos generating a pregnancy and failing to produce a pregnancy were determined using the pooled t-test. Differences in conception rates for embryos establishing a pregnancy with PA production above the selected threshold compared to embryos with PA production equal to or below the selected threshold PA production were determined using Chi-square analysis. All analyses were performed using the NCSS statistical software program (Number Cruncher Statistical System; 2000, Jerry Hintze, Kaysville, UT).

Results

Forty-seven embryos with normal morphology were collected from 10 superovulated donors. Following culture, embryos were graded and assigned quality scores and 33 embryos were transferred to timed recipients. Eight of 33 recipients (24%) were diagnosed pregnant. Mean PA production and post-culture quality scores for embryos generating a pregnancy vs. failing to generate pregnancy did not differ (P>0.10) (Table 1). Percentages of embryos that resulted in pregnancies with PA production below or equal to vs. above selected threshold values for PA are reported in Figure 1. No differences (P>0.10) in the percentages

of embryos that resulted in pregnancies were observed for embryos with PA production below or equal to vs. above any of the threshold values. However, when the threshold value was 0.3 mIU PA/ml/h, only 1 of 11 (9%) embryos with PA production below or equal to this value produced a pregnancy. The 11 embryos with PA production below this threshold value represented 33% (11/33) of the total number of embryos transferred.

Table 1. Plasminogen activator production (PA; mIU/ml/h) and quality scores (Quality) for embryos transferred to recipients resulting in successful (Pregnant) or failed (Nonpregnant) pregnancies.

	Recipient status		P-value
	Pregnant	Nonpregnant	
PA[a]	1.3 ± 0.5	4.6 ± 2.8	0.51
Quality[a]	3.2 ± 0.2	3.1 ± 0.2	0.60
Number of embryos	8	25	--

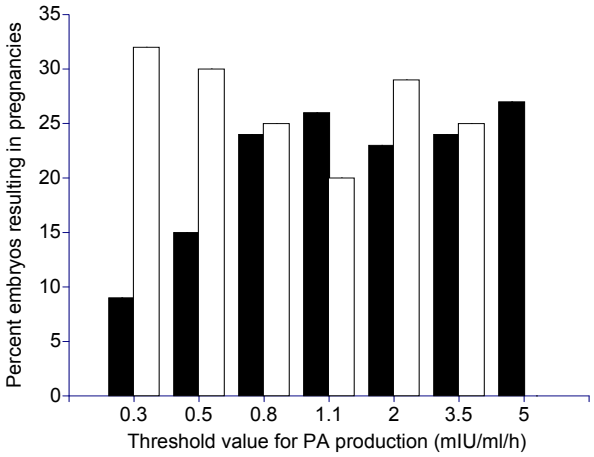

Figure 1. Percentages of embryos resulting in pregnancies with plasminogen activator (PA) production equal to or below (■) or above (□) the selected threshold value. Values above the bars are the total numbers of embryos represented by each bar.

Although significant differences in PA production and pregnancy rates were not realized in this experiment, results associated with implementing a PA threshold are encouraging. Only 1 out of 11 embryos producing less than 0.3 mIU PA/ml/h generated a pregnancy whereas 7 out of 22 embryos producing above threshold PA resulted in pregnancies, increasing the pregnancy rate from the overall 24% to 32%. If the PA threshold was put in practice as a criterion for embryo selection, it is clear 1 embryo out of 11 below threshold would have been discarded which, if transferred, would have resulted in a pregnancy. However, the ultimate question is whether the single pregnancy would compensate for the expense and time involved in transferring 10 below threshold embryos that failed to result in pregnancies and maintaining the 10 open recipients.

Two aspects of this study clearly require refinement. First, the pregnancy rate of 24% is low and should be increased to approach industry standards. However, in defense of the pregnancy rate reported in this study, embryos were cultured for 22 h before transfer and extended culture such as this has been shown to depress pregnancy rates. Second, variability in embryonic PA production was particularly high in embryos failing to generate pregnancies. Our laboratory has long suspected that a dying embryo releases PA in a burst because of membrane damage whereas a viable embryo would release PA in a controlled fashion. One solution to manage both the pregnancy rate and the uncontrolled PA release by dying embryos is to culture the embryos for a shorter period of time, e.g., 2-4 h. Although some time in culture is required to obtain measurable amounts of PA, subsequent embryo transfers will be performed within 4-5h of collection in contrast to 22-24 h. This modification should have a twofold effect. Pregnancy rate should increase because of the shorter time embryos are spent in culture and out of the uterus. Variability in PA production should also decrease because the shorter culture period would narrow the window of time where an embryo could die and spontaneously release PA.

Conclusions

Quantifying plasminogen activator production has demonstrated some efficacy for selecting embryos for transfer that can at least reduce the number of recipients receiving embryos which will not result in pregnancies.

Acknowledgements

This research was generously supported by the Oregon Beef Council and the Oregon Agricultural Experiment Station.

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Oregon State University

BEEF071

Beef Cattle Sciences

Oregon Beef Council Report

Production Value and Efficiencies of Replacement Beef Heifers Sired by either High or Low-Marbling Bulls [1]

Chad J. Mueller[2], Tim DelCurto[3], Hannah DelCurto[4], and Duane Keisler[5]

Synopsis

Selecting sires based on marbling potential for value-added beef programs may impact the reproductive efficiency of retained daughters for replacement heifers. The impact of sire marbling selection may also affect carcass merit of the daughter's offspring.

Summary

One hundred-two replacement heifers were developed from the 2005 and 2006 breeding season, in which dams were bred to either a high-marbling EPD (HIGH) or low-marbling EPD (LOW) Angus sire. Heifers were condition scored, ultrasonographed for carcass estimates, and blood sampled at a year of age for potential measures to predict future reproductive and offspring performance. Reproductive data and growth and carcass merit data of offspring were collected in 2009, 2010, and 2011. Blood samples were analyzed for concentrations of insulin-like growth factor 1 (IGF-1), growth hormone, and Leptin. The reproductive performance of the heifers indicated that the LOW group had more calves born, thus increasing the number of calves weaned. Evaluation of calving interval showed a trend that LOW heifers were approximately 5 days longer between calves, thus potentially altering future calving cycles. The offspring of HIGH heifers were lighter at birth, but were similar in weight to the offspring of LOW heifers at weaning and time of slaughter. Carcass values did not indicate any differences ($P > 0.10$) between marbling groups, but the numeric values indicate an improvement in most carcass merit values of HIGH offspring. Additional calf crops are needed to reassess the current data trends. Selection of sires based on marbling potential may impact both the reproductive performance of the retained daughters, and their subsequent offspring performance.

Introduction

The current beef industry is experiencing some major challenges and changes in regards to production management, especially nutritional management. The biofuel era (both ethanol and biodiesel) has resulted in more crops being diverted to fuel production and less towards livestock feeding. It has also resulted in more forage acres being diverted to grain production. Both of these factors have resulted in smaller feedstock supplies being sold at higher prices. As a result, the cost associated with adding a pound of weight gain to feeder cattle has (in some places) more than

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2. Assistant Professor, Oregon State University – EOARC, Union, 97883. Email: chad.mueller@oregonstate.edu.
3. Superintendent, Oregon State University – EOARC, Union, 97883. Email: tim.delcurto@oregonstate.edu.
4. Undergraduate student, Kansas State University, Manhattan
5. Professor, Division of Animal Sciences, University of Missouri, Columbia.

doubled. Commodity beef prices have not increased in a similar manner, therefore profit margins are constantly shrinking at both the cow/calf and feeder segments. During the last 10 to 15 years, branded beef programs have seen substantial growth with more cow/calf operations joining to capture more value from their calf crop. Most of the captured value is in either/both better quality (i.e. improved marbling, increased lean yield, etc.) and/or improved consistency. As more producers start evaluating these various "branded" or "value-added" programs, they will start scrutinizing their breeding programs much more intently. The current study was developed to begin evaluating the long-term ramifications of retaining breeding females bred for certain marbling traits on the reproductive performance and terminal offspring production.

Materials and Methods

All procedures involving animals were approved by the Oregon State University Institute of Animal Care and Use Committee. During the 2005 and 2006 breeding season the cowherd at the EOARC Union station were artificially inseminated (AI) to either a high marbling EPD Angus bull (HIGH; Marbling EPD: +0.44, Acc: 0.23) or a low marbling EPD Angus bull (LOW; Marbling EPD: +0.02, Acc: 0.30) as evaluated by the American Angus Association. The sires selected represent Angus bulls in both the top and bottom 5% for carcass marbling, respectively. One hundred-two replacement heifers were retained from the combined breeding years.

At a year of age heifers were ultrasonographed for intramuscular fat or marbling (UMARB), longissimus muscle depth (UMD), and subcutaneous fat or backfat (UBF). Ultrasound measurements were obtained at the 12^{th} to 13^{th}-rib interface by an experienced technician using an Aloka 500V (Aloka Co., Ltd, Wallingford, CT) B-mode instrument equipped with a 3.5-MHz, 125 mm general purpose transducer array (UST-5011U-3.5). Images were collected by a single technician with software from the Cattle Performance Enhancement Company (CPEC, Oakley, KS). Estimates of UBF, UMD, and UMARB were based on image analysis programming (Brethour, 1994) contained within the CPEC software program. Blood was collected via jugular venipuncture into K_2EDTA-preserved collection tubes. Blood samples were centrifuged and plasma was harvested, stored, and frozen for later analysis. Plasma samples were shipped to the University of Missouri for determination of Leptin and Insulin-like growth factor 1 (IGF-1) concentrations.

Various production parameters were monitored through the 2011 production cycle using cow and calf body weights, breeding and calving records, and cumulative calf carcass data. Production data was maintained in a commercial beef cattle database (CowSense, Midwest MicroSystems LLC, Lincoln, NE).

Data was analyzed as a one-way analysis of variance comparing HIGH versus LOW marbling sires, using the residual error as the error term. All analyses were conducted using Mixed Model procedures of SAS (SAS Institute, Cary, NC). Heifers from 2006 were deleted from the dataset due to the discovery that the sire data used to identify replacement heifers had been compromised and the HIGH heifers were subsequently sold. Pearson Correlation Coefficients between ultrasound measurements, blood metabolites, and carcass data were developed using the Correlation procedures of SAS.

Results

Heifer performance

At the time of yearling measurements (Table 1) there were no differences ($P > 0.10$) in body weight or body condition score between the marbling groups. This would indicate that growth and ability to retain energy reserves may be similar between sire groups; possibly the result of their crossbred dam's. Though subjective condition scoring did not indicate differences in fat deposition, ultrasound measurements (Table 1) did indicate that HIGH heifers had greater ($P < 0.10$) fat deposition in regards to subcutaneous and intramuscular fat. Both IGF-1 and growth hormone are metabolically related to an animal's growth and deposition of lean tissue. The HIGH heifers had greater ($P < 0.01$) concentrations of IGF-1, though concentrations of growth hormone were similar ($P > 0.10$) between marbling groups. Blood concentrations of Leptin (a fat hormone) were not different ($P > 0.10$) between marbling groups.

After evaluation of the reproductive performance (Table 2) of these heifers from 2009 through 2011 (only evaluating 2007 heifers), the LOW group tended ($P = 0.052$) to have more calves born (2.94) versus the HIGH heifers (2.47). The difference in calves born translated into LOW heifers weaning more calves (2.06) versus the HIGH

heifers (1.83). The 30 and 26% reduction in weaned calves (compared to calves born in LOW and HIGH heifers, respectively) was the result of greater than normal weather-related pre-weaning calf deaths in 2010. The MPPA (Most Probable Producing Ability) of the two groups indicate that the HIGH heifers should produce more pounds of weaned calf at constant 205 d of age. Calving interval, or the number of days between calf births, was similar between marbling groups (Table 2). The difference in calving interval is only 5.4 d, but that also indicates that every 4 years the LOW heifers will cycle a full 21 d after the HIGH heifers.

Table 1. Yearling measurements of beef heifer daughters from either a high- or low-marbling Angus sire.

Item	LOW[a]	HIGH[a]	SEM	P =
N =[b]	22	21	---	---
Weight, lb.	888.7	900.0	13.58	0.56
Condition score[c]	5.2	5.2	0.05	0.98
	Ultrasound measurements			
Backfat, in.[d]	0.15	0.17	0.006	0.075
Muscle depth, in.[e]	2.12	2.02	0.038	0.072
Marbling score[f,g]	4.05	4.33	0.073	0.011
	Blood metabolites			
IGF-1, ng/ml[h]	67.88	86.53	4.707	<0.01
Growth hormone, ng/ml	3.14	2.54	0.360	0.25
Leptin, ng/ml	1.53	1.36	0.211	0.58

[a]LOW = low marbling Angus sire, HIGH = high marbling Angus sire.
[b]2007 retained heifer calves only.
[c]Visual body condition score obtained at approximately one year of age; values are averages of two independent observers.
[d]Ultrasound estimate of subcutaneous fat depth
[e]Ultrasound estimate of longissimus dorsi muscle depth
[f]Ultrasound estimate of intramuscular fat deposition (marbling)
[g]3.00 = slight (select), 4.00 = small (low choice), 5.00 = modest (average choice).
[h]Insulin-like growth factor 1.

Offspring performance

Table 2 summarizes various measures of the offspring from both marbling groups. Birth weights of calves from LOW heifers are heavier (P = 0.039), but pre-weaning gain is less resulting in similar weaning weights to the calves from HIGH heifers. The similar weaning weights would also contradict the MPPA values previously mentioned. The difference is probably the result of the longer (greater than 205 d) pre-weaning period. Calves that are older than 205 d of age will start developing at different rates (due to changes in physiological development), and therefore weaning weights adjusted back to 205 d of age may be partially skewed and alter the MPPA values.

Carcass characteristics of the offspring do not indicate any differences ($P > 0.10$) in carcass merit (Table 2). Though statistically there were no carcass measurement differences, the values reported from such a small population of offspring indicates some potential differences. Numerically, calves from the HIGH females had heavier carcass weights, greater ribeye area, and higher marbling scores. Further accumulation of carcass data is warranted to determine whether these numerical differences continue to favor the HIGH heifers.

Table 2. Reproductive and offspring performance of beef heifer daughters from either a high- or low-marbling Angus sire.

Item	LOW[a]	HIGH[a]	SEM	P =
Calves born	2.94	2.47	0.165	0.052
Calving interval, days[b]	374.5	369.1	2.59	0.15
Calves weaned	2.06	1.83	0.075	0.044
MPPA[c]	99.1	104.3	1.45	0.024
	Offspring performance			
Birth weight, lb.	82.2	76.6	1.84	0.039
Weaning weight, lb.	607.4	619.5	17.19	0.62
Carcass weight, lb.[d]	748.9	775.0	15.72	0.25
Backfat, in.	0.51	0.55	0.027	0.38
Ribeye area, in^2	13.53	14.05	0.299	0.23
KPH, %[e]	2.16	2.19	0.121	0.86
Yield grade	2.72	2.64	0.135	0.69
Marbling score[f]	472	531	26.6	0.13

[a]LOW = low marbling Angus sire, HIGH = high marbling Angus sire.
[b]Days between calf births.
[c]Most Probable Producing Ability. Ratio based on the breeding female's cumulative average adjusted 205-d weight of her calves.
[d]Hot carcass weight (slaughter).
[e]Kidney, pelvic, and heart fat.
[f]400 = slight (select), 500 = small (low choice), 600 = modest (average choice).

Correlation coefficients

Both the ultrasound and blood metabolite data was used to determine possible relationships between heifer measurements and offspring carcass merit (Table 3). Correlation coefficients less than 0.30 are weak, 0.30 to 0.60 are moderate, and greater than 0.6 are strong relationships. Estimated muscle depth was moderately correlated (P = 0.08) with ribeye area of offspring, while estimated marbling of yearling heifers were moderately correlated (P =

0.05) with offspring marbling score. No other ultrasound measurements seemed to be related to the selected offspring carcass measurements. Regarding the measured blood metabolites, only Leptin showed a relationship to any of the offspring carcass variables. Both IGF-1 and growth hormone concentrations show weak relationships to marbling score and yield grade (< 0.30 coefficient), though the coefficients were not statistically different. Leptin concentrations were moderately correlated to carcass weight (P = 0.02) and ribeye area (P = 0.15). Speculatively, Leptin concentrations in the dam may indicate greater ability to store energy reserves and thus improve her ability to produce milk for the pre-weaned calf (resulting in improved growth and carcass merit). Though many of these relationships are considered weak to moderate in correlation, the small number of heifers and subsequent offspring lend to the conclusion that both ultrasonography and specific blood metabolites may be useful in determining carcass quality of future offspring.

Table 3. Pearson correlation coefficients [a] of select offspring carcass variables and beef heifer yearling measurements.

	Offspring carcass variables			
Item	HCW [b]	REA [c]	Marbling score	Yield grade
Ultrasound measurements				
Backfat	0.072 (*0.72*)	0.019 (*0.92*)	0.066 (*0.74*)	0.216 (*0.30*)
Muscle depth	0.158 (*0.43*)	0.345 (*0.08*)	0.092 (*0.65*)	0.222 (*0.29*)
Marbling score	0.006 (*0.98*)	0.094 (*0.64*)	0.374 (*0.05*)	0.093 (*0.66*)
Blood metabolites				
IGF-1	0.084 (*0.70*)	0.023 (*0.92*)	0.293 (*0.17*)	0.284 (*0.21*)
Growth hormone	0.097 (*0.66*)	0.083 (*0.70*)	0.217 (*0.32*)	0.045 (*0.85*)
Leptin	0.485 (*0.02*)	0.311 (*0.15*)	0.075 (*0.73*)	0.087 (*0.71*)

[a] P-values are listed in parentheses.
[b] Hot carcass weight.
[c] Ribeye area.

Conclusions

The current dataset is small and only includes heifers from a single breeding season, though both heifer reproductive performance and offspring carcass merit indicates that selecting heifers based on sire marbling potential may impact herd performance. The LOW heifers may produce offspring that have reduced carcass merit (compared to HIGH heifers), but the potential higher financial returns from the improved reproductive performance would more than offset the reduced carcass premiums. The limited data presented indicates that selection for marbling characteristics may impact both reproductive performance of daughters and carcass merit of their offspring, therefore breeding decisions based on value-added programs can potentially impact overall herd performance.

Acknowledgements

The authors would like to thank the Oregon Beef Council for financial support of the project.

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Oregon State University

BEEF070

Beef Cattle Sciences

Oregon Beef Council Report

Impact of Nutrient Resources during Bull Development on Calf Crop Growth through Slaughter[1]

Chad J. Mueller[2], Tim DelCurto[3], and Randy R. Mills[4]

Synopsis

The use of a forage-based beef sire to improve utilization of fiber-based diets for growth were not evident during the backgrounding phase, and resulted in less beef produced at time of slaughter. The use of conventional sires promoted improved finishing performance and carcass merit.

Summary

One hundred seven Angus-based calves were backgrounded for 45 d on either a fiber-based or starch-based diet. Calves were either sired from a conventional grain-based developed Angus sire (CONV) or a forage-based developed Angus sire (FORAGE). Sire sources were stratified across backgrounding diets to determine the effect of sire and the interaction of sire and diet on calf growth and carcass merit. There were no differences ($P >$ 0.10) in ADG or total gain during the backgrounding period between sire sources, and sire source did not impact growth of calves consuming either backgrounding diet. The CONV calves had higher ADG during the finishing period, and subsequently heavier carcass weights. From a carcass merit standpoint, the CONV calves had greater ribeye area, a higher marbling score, and a lower yield grade. The current study evaluated calf performance through a typical U.S. production scenario which favored the CONV calves, therefore the performance of these calves through periods of extended forage consumption may have altered production efficiencies within each sire.

Introduction

In recent years large fluctuations in feed commodity prices have placed new challenges on beef producers in the U.S., especially the Pacific Northwest. Since the 1950's beef producers in the U.S. have had abundant access to cheap grains, which has led to less emphasis on efficiency of forage use and management. As a result the beef breeds used in our current beef industry revolve around cheap gains and maximizing total pounds of calf produced. The potential downside to this selection is that we 'lose track' of how efficient the cow is (other than total pounds of calf produced), especially on limited forage resources, and we evaluate the "production efficiency" of the offspring based on readily available energy resources. Due to recent feed commodity price fluctuations some producers have begun to re-evaluate their breeding programs, and are attempting to refocus on genetics that emphasize forage utilization. With this change some companies have advertised the use of "grass cattle" or "forage genetics" to improve the herds.

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2. Assistant Professor, Oregon State University – EOARC, Union, 97883. Email: chad.mueller@oregonstate.edu.
3. Superintendent, Oregon State University – EOARC, Union, 97883. Email: tim.delcurto@oregonstate.edu.
4. Staff Chair, Oregon State University Extension Service, Umatilla County, Pendleton, 97801. Email: randy.mills@oregonstate.edu.

Sustainable Genetics (Carrollton, GA) is one such company, indicating "*There are two types of cattle today, "**corn cattle**" and "**grass cattle**". Our many years of experience have taught us that "grass cattle" will work in a corn environment; however "corn cattle" in a forage environment is not sustainable"*. Because of these claims, and increasing interest in these genetic programs from producers, new research (currently there is little-to-no research data in this area) needs to evolve to evaluate this type of genetic selection. Therefore the current study was designed to begin evaluating gain performance and carcass merit of the terminal offspring sired either grain-based or forage-based genetics in a typical U.S. production scenario.

Materials and Methods

All procedures involving animals were approved by the Oregon State University Institute of Animal Care and Use Committee. During the 2010 breeding season the EOARC-Union cow herd was artificially inseminated (AI) to one of two sires: 1) an Angus sire developed in a conventional grain-based program typically found in the U.S. (**CONV**), or 2) an Angus sire developed in a forage-based program typically found in New Zealand (**FORAGE**). At time of weaning in October 2010 one hundred-seven newly weaned calves from both sire sources were identified and assigned to either a starch-based or fiber-based backgrounding diet (Table 1). Diets were formulated to contain a minimum of 13.5% CP (DM basis) with vitamin and mineral levels comparable with NRC (1996) recommendations. Daily feed amounts were programmed to achieve a minimal gain of 0.75 $lb \cdot hd^{-1} \cdot day^{-1}$ based on NRC (1996) gain equations. The concentrate portion (Table 1) of the diets were fed in open bunks once per day (0800 h), with long-stem grass hay provided on an ad libitum basis using open access hay feeders.

Calves were backgrounded for approximately 45 d, with body weights (unshrunk) collected at the beginning and on d 46 prior to feedlot transit. Final backgrounding body weights were pencil shrunk 3%, though due to differences in potential gut fill between soybean hulls and barley neither the pencil shrink nor a 12 h shrink would properly compensate for fill differences when comparing diets. Calves were then shipped 135 miles to a commercial feedlot for finishing. During the feedlot phase cattle received an anabolic implant (Revalor, Intervet Inc., Summit, NJ) and were fed a common diet in a common pen. Once cattle reached approximately 0.4 inches of backfat, based on visual appraisal by feedlot management, cattle were transported to a commercial abattoir for slaughter (Tyson Fresh Meats, Wallula, WA). Carcass data was collected on all cattle within 24 h of slaughter by trained personnel.

Data was analyzed as a two-way analysis of variance (ANOVA) with the main effects of sire and diet tested using residual error as the error term. The interaction of Sire × Diet was tested using calf within Sire × Diet as the error term. All statistical analyses were conducted using MIXED procedures of SAS (SAS Institute, Cary, NC).

Table 1. Formulation and nutrient composition of both starch-based and fiber-based backgrounding supplements[a]

	Backgrounding supplement	
Item	**Starch**	**Fiber**
Rolled barley	44.81	---
Soybean hulls	---	46.98
Soybean meal	55.19	53.02
Nutrient analysis		
Dry matter, %[b]	89.1	89.0
Crude protein, %[b]	33.74	32.84
NDF, %[b]	13.93	48.94
ADF, %[b]	6.45	24.79
NEg, Mcal/100 lb.[c]	65.8	61.7

[a]Grass hay and mineral supplements were provided ad libitum through self feeders. Supplement consumption was estimated to be 20% of daily DM intake (based on NRC, 1996).
[b]Based on laboratory analysis.
[c]Estimated using NRC (1996) tabular values.

Results

Post-weaning performance and carcass data are summarized in Table 2. The FORAGE calves were lighter ($P = 0.068$) than their CONV counterparts at the beginning of backgrounding, but gained adequate weight during the 45 d period to obtain similar body weights prior to the finishing period. No calves from either genetic group were treated for sickness or died during the backgrounding period (data not shown). When evaluating the data for interactions of backgrounding diet type and sire nutritional development, there was no indication ($P > 0.10$) that sire performed differently on the two different diets. Though number of calves were statistically adequate for the

study, a longer backgrounding period may have resulted in a different outcome for the sire groups based on total gain and animal variation reported.

The CONV calves performed better during the finishing period with a higher ADG (3.64 vs 3.43 lb/d for CONV and FORAGE, respectively) and greater final weight (P = 0.030) at time of slaughter. The CONV calves had heavier carcass weights, a larger ribeye area, and greater marbling scores versus the FORAGE calves (Table 2). The FORAGE calves had greater backfat accumulation which translated into a higher yield grade. When evaluating the data for interactions of backgrounding diet type and sire group, there were no indications that the backgrounding program had long-term effects on calf development regardless of sire group.

Conclusions

The use of 'forage-based' sires may continue to gain favor in the U.S. beef industry, but the current data indicates that any differences in terminal offspring performance may be minor and not translate into an economic advantage. Calves from the FORAGE sire gained adequately to obtain similar body weights at the beginning of the finishing period, but had lower finishing gain performance and reduced carcass characteristics in relation to quality grade carcass pricing grids.

Acknowledgements

The authors would like to thank the Oregon Beef Council for financial support of this project.

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Table 2. Gain performance and carcass characteristics of calves sired by sires nutritionally-developed on either a conventional grain-based system or forage-based system.

	Sire [a]			*P* values [b]	
Item	Conventional	Forage	SEM	Sire	Sire x Diet
Backgrounding period					
Beginning weight, lb.[c]	707.5	683.7	9.11	0.068	---
End weight, lb.[d]	749.2	731.9	9.21	0.18	0.88
ADG, lb.	0.93	1.08	0.073	0.17	0.64
Finishing period					
End weight, lb.[e]	1311.9	1254.2	18.52	0.030	0.87
ADG, lb.[f]	3.64	3.43	0.076	0.058	0.99
Carcass characteristics					
Hot carcass weight, lb.	824.8	785.6	12.02	0.024	0.88
Backfat, in.	0.54	0.64	0.023	0.005	0.46
Ribeye area, in^2	14.24	13.65	0.203	0.038	0.51
KPH, %[g]	2.29	2.09	0.101	0.15	0.34
Marbling score[h]	508.6	434.7	12.77	<0.001	0.85
Yield grade[i]	2.90	3.13	0.083	0.046	0.88
Retail yield[j]	50.01	49.47	0.192	0.049	0.89
REA:HCW ratio[k]	1.73	1.74	0.022	0.85	0.44

[a]Sire sources: Conventional = Conventional grain-based sire (Bextor), Forage = Forage-developed New Zealand sire (Wiegroup 41/97).
[b]P > 0.10 is considered non-significant.
[c]Non-shrunk body weight.
[d]Includes 3% pencil shrink.
[e]Calculated using carcass weights divided by dressing percentage (steers = 63%, heifers = 61%).
[f]Calculated using backgrounding end date/weight and kill date/finishing end weight.
[g]Kidney, pelvic, and heart fat.
[h]300 = slight (Se), 400 = small (Ch^-), 500 = modest (Ch^0), 600 = moderate (Ch^+)
[i]Calculated as: yield grade = 2.5 + (2.5*backfat) + (0.0038*carcass weight) + (0.2*KPH) – (0.32*ribeye area)
[j]Calculated as: % retail yield = 51.34 – (5.78*backfat) – (0.0093*carcass weight) – (0.462*KPH) + (0.740*REA).
[k]Calculated as: ribeye area ÷ (hot carcass weight ÷ 100).

Beef Cattle Sciences

Oregon Beef Council Report

Progress Reports – Animal Sciences[1]

A Pilot Study to Evaluate the Association of Metabolic Disorders in Early Lactation and the Incidence of Anoestrus in Dairy Cows

Contact Person: Aurora Villarroel and Ben Krahn - OSU Department of Animal Sciences
Address: 113 Withycombe Hall; Corvallis, OR 97331
Phone Number: (541) 207-8003
Email: aurora.villarroel@oregonstate.edu and ben.krahn@oregonstate.edu

Project Objectives: To objectively measure the association between early metabolic disease and the incidence of anoestrus in dairy cattle.

Project Start Date*:* August 2010
Expected Project Completion Date: August 2011

Project Status: A total of 90 cows have been enrolled in the study and all data have been recorded. Statistical analyses are to be performed by the end of the year. Preliminary results have been presented at various states, national and international venues including the World Buiatrics Conference in Chile, and two invited presentations in Italy and Israel. Two scientific manuscripts will be prepared for peer-reviewed publication in 2012, and more results are expected to be presented at extension and scientific meetings and published in the future editions of the Oregon Beef Council Report.

Western Juniper - Induced Abortions in Beef Cattle

Contact Person: Cory T. Parsons – OSU Baker County Extensions Service
Address: Baker City, OR 97814
Phone Number:
Email: cory.parsons@oregonstate.edu

Project Objectives: The goal of this study is to determine high, medium and low risk areas for potential juniper-induced abortions in cattle and provide management recommendations to OSU extension, and Oregon cattle producers to reduce cattle losses. The objectives of this study are three fold:

1- Determine the extent of the potential variation in the concentration of abortifacient compounds in western juniper trees across cattle grazing regions of Oregon.
2- Determine if there are seasonal, geographical, or other factors which alter the concentration of abortifacient compounds in western juniper trees in Oregon.
3- Further assess the potential of western juniper trees to induce late term abortions in beef cattle by dosing more animals with plant material.

Duration of study: Objective 1 – two months to collect, prepare, chemically analyze, and catalog the samples. Objective 2 – two years to collect samples and then prepare and chemically analyze samples.

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.

Objective 3 – one year to purchase cows, time breed them, maintain them for six months in dry lot until 250 days gestation at which time cows will be dosed via stomach tube for 10 days (gestation days 250-259).

Project Status: Objective 1 has been accomplished with the final chemical analysis being interpreted. Based upon the results of Objective 1, we will begin Objective 2 immediately, followed next fall, winter and spring with Objective 3. The results of this study will then be published in appropriate publications with the beef cattle producers across the state being better informed and educated regarding the potential of Western Juniper to cause premature births, (abortions) in beef cattle.

The Economics of Grassed-Based Dairying in Oregon

Contact Person: Troy Downing – Professor, Dairy Extension, Tillamook, OR.
Address: 2204 4th St., Tillamook, OR 97141
Phone Number: (503) 842-3433
Email: troy.downing@oregonstate.edu

Project Objectives: Grazing milk cows in Oregon is not a new practice or technology. However, in the past few years some dairymen have been uniquely successful by selecting bulls from New Zealand milk cow genetics, switching to seasonal calving and adopting progressive pasture management techniques. The objective of this project is to help these dairymen design a system to successfully document pasture growth, feed quality, utilization, milk production and work with them to gather this data. We will also utilize advanced forage measurement equipment (C-Dax), techniques and software to monitor pasture productivity and utilization. This project will us understand and incorporate NZ dairy industries approach to the US and generate data on two cooperative dairies in Oregon. At the completion of this project we will be able to calculate the value and quantity of pasture grown, the return to management, and the pounds of milk solids produced per acre.

Project Start Date*:* February 2012
Expected Project Completion Date: February 2013

Project Status: Cooperating dairies have been located and equipment is in the process of being ordered.

Yeast Culture Supplementation Improves Feed Consumption in Cattle

Contact Person: Gerd Bobe – Oregon State University
Address: 112 Withycombe Hall - Corvallis, OR 97331
Phone Number: (541) 737-1898
Email: shelby.filley@oregonstate.edu and janice.hunter@oregonstate.edu

Project Objectives: Determine 0, 56, or 112 g/d of yeast culture fed from 4 weeks pre-calving to 4 weeks post calving increases feed consumption around calving by altering serum markers of hunger and satiety.

Project Start Date*:* October 2011
Expected Project Completion Date: October 2013

Project Status: Multiparous Holstein cows (32 cows per group; 96 cows total) were fed individually in addition to their regular diet 0, 56, or 112 g/d of yeast culture (Diamond V XP®, Diamond V, Cedar Rapids, IA) from 4 weeks before calving to 4 weeks after calving. The animals were maintained at a commercial dairy and the study was approved by the Oregon State University Animal Care and Use Committee. Blood samples were taken 28, 14, 7, and 3 days before the anticipated calving date, at calving, and 3, 7, 14, 21, and 28 days after calving. Milk samples were taken twice a week. The health of the cows was monitored daily until 100 days after calving. Treatments and their costs were recorded until 305 days after calving or until the cow left the farm, whichever came first. We started to quantify serum markers of hunger (i.e., ghrelin) and satiety (i.e., cortisol, leptin, and visfatin) in serum samples. As soon as all serum samples are analyzed and statistically summarized, the results will be published in the next edition of the Oregon Beef Council Report, and presented at extension and scientific meetings. The results will be published into extension materials and scientific literature.

Oregon State University

BEEF072

Beef Cattle Sciences

Oregon Beef Council Report

Using Western Juniper Leaf Extract as a Bioherbicide to Control Cheatgrass and Medusahead on Western Rangelands [1]

Patricia L. Dysart[2] and Carol Mallory-Smith[3]

Synopsis

In our initial greenhouse study, two new bioherbicide formulations developed from the leaves of western juniper (*Juniperus occidentalis* Hook) trees in conjunction with standard weed control additives showed significantly increased phytotoxicity to both cheatgrass (*Bromus tectorum* L.) and medusahead (*Taeniatherum caput-medusae* (L) Nevski) seedlings versus the raw juniper aqueous leaf extracts alone and warrant further development. Application rates were higher than standard application rates for commercial herbicides.

Summary

The primary objective of this experiment was to evaluate a initial range of new bioherbicide formulations using a 15% and 25% w/v aqueous extract made from western juniper leaves as the base ingredient with a crop oil (juniper oil) and surfactant/spreader (R11 ®) added in an effort to increase its phytotoxicity against cheatgrass and medusahead seedlings in a post-emergence spray application. Seedlings were sprayed at the 2-leaf stage, and seedling vigor was subjectively evaluated at 24 hr and 1 week after application on a scale of 0-5 (0 dead, 5 excellent condition). Results showed that at the highest additive concentrations and application rates, after 24 hr seedling vigor of both species was reduced by 30-95% and after 1 week all seedlings were dead, even in the R11 only treatments. After only 2 hr., the raw extract treatments + juniper oil treated seedlings showed signs of extreme deterioration. The raw aqueous extract treatments alone showed no difference to the control plants. This result indicates that improving residence time in contact with the leaf surface and uniform distribution of droplets may be needed for the raw extract to be effective. Although, a second smaller experiment using the raw extract + R11 in lower concentration ranges on larger seedlings had no effect, overall these are encouraging results. Our previous work has shown that the raw aqueous extracts are significantly effective at reducing soft-coated seed germination (preemergence) by possibly interfering with mitotic bundle formation in root tips as the mode of action. These post-emergence results indicate that a raw juniper leaf aqueous extract in combination with standard weed control additives may also be effective in post-emergent applications. These results are important because they provide a more defined direction for future 'juniperocide' development.

The second objective was to continue to characterize the raw aqueous extract. The actual phytotoxic compound(s) in the raw extract have not

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Research Associate, Oregon State University – 107 Crop Science Bldg, Corvallis, OR. Email: Pat.Dysart@oregonstate.edu
3. Professor of Weed Science, Oregon State University – 107 Crop Science Bldg, Corvallis, OR. 97331 Email: Carol.Mallory-Smith@oregonstate.edu

yet been identified, but based on our previous 'juniperocide' characterizations and recent HPLC analysis, the more hydrophilic compounds, glycosides 1 and 2 and their aglycones 1a and 2a, were prominently present in the aqueous extract. Cleavage by heat inactivation of the glycosides may be the mechanism for the release the actual allelochemicals (aglycones). This may increasingly occur, for example, under doughtier conditions making leachable compounds from western juniper leaves more phytotoxic. To date, our key HPLC peaks include: 2 unknown glycosides and their unknown aglycones, catechin, epicatechin, cupressuflavone, amentoflavone, cupressuflavone-4'-O-methyl ether, and siderin.

It has been known for a long time that oil distilled from western juniper leaves contains phytotoxic terpene compounds such as sabinene, α-pinene, α and γ-terpinene, and limonene (Rudloff 1980). Our preliminary data also indicates that the essential oil fraction of juniper leaves has significant herbicidal activity. The following volatile terpenoids were (tentatively) identified by GC comparison with standards available in the Hops Research Laboratory at Oregon State University: α-pinene, β-pinene, myrcene, linalool, and caryophyllene

However, the observed herbicidal activity of the aqueous extract cannot be contributed to the presence of volatile terpenoids, because the herbicidal activity of the aqueous extract was retained after removal of volatile terpenoids by steam distillation. Since we don't yet know the active ingredient(s), A.I. application rates/acre cannot explicitly be calculated at this time. Toxicity is based on total volume of solution.

Introduction

Medusahead and downy brome are two annual grasses that have formed mono-cultures on many rangelands in Oregon and in the Great Basin. They have been difficult to control and thousands of dollars each year are spent on chemical herbicides such as Plateau® in attempt to manage and restore these infestations. Although now considered to be a 'native' western juniper woodlands in eastern and central Oregon have also expanded onto rangeland outside of their traditional boundaries. All three species present problems for areas that are invaded by out-competing with native grasses for limited resources thereby decreasing native grass range and severely limiting forage for grazing animals. Development of a bioherbicide using western juniper leaves would not only provide an incentive for management of the juniper woodlands, but by targeting the invasive grasses, weed control and restoration costs may be significantly reduced, increased jobs may be available in rural areas for production, and a natural bioherbicide could be added to the existing methods of invasive grass control.

It has been known for a long time that oil distilled from western juniper leaves contains phytotoxic terpene compounds such as sabinene, α-pinene, α and γ-terpinene, and limonene (Rudloff 1980). A previous project done in 1996-97 as part of the Western Juniper Commercialization Project at Oregon State University (http://juniper.orst.edu/oils_abs.htm) and done on the Warm Spring Reservation focused on using this oil in specialty juniper retail products. The results of that study showed that at that time the cost/benefit ratio for production of the oil was too high to be profitable.

In the scope of the overall 'juniperocide' project, it was decided to look again at the possibility of using juniper leaf extracts, but instead of distillation of the oil, we examined simple aqueous extracts at various concentrations and tested their effectiveness at suppressing weed seed germination in the laboratory and greenhouse at OSU and in the field on the Warm Springs Reservation. We were successful with the preemergence work and these post-emergence trials represent an expanded scope of the project. And use of only milliliters of juniper oil in a extract form may change the cost/benefit ratio to produce that as well.

Materials and Methods

Objective 1

A combination matrix of two levels of the base juniper extract (15% and 25% w/v), one level of a crop oil (juniper oil 5%) and four levels of R11, a non-ionic spreader/activator (0.5%, 1%, 3.3%, and 5%) were tested under standard greenhouse conditions set for 12 hours daylight and 24/20 C day/night temperatures. Twenty-five (25) medusahead and cheatgrass seeds were planted into standard half-flat trays. Three (3) trays of each species were planted per treatment. Seedlings were left to grow to the 2-leaf stage and then sprayed with 60 ml of 15% and 25% w/v raw extract, 15% and 25% raw extract + 5% juniper oil, 15% and 25% raw

extract + 5% juniper oil + 5% R11. Based on the results of the first experiment, another set of seedlings were sprayed with 30 ml using only 15% and 25% raw extract + R11 at 0.5%, 1%, 3.3%. Seedling vigor was subjectively rated on a scale from 0-5 versus the control plants (0 = worst seedling condition, 5 = best seedling condition) at 24 hr, and 1 week. All experiments will be repeated.

Objective 2

All extracts, essential oil distillations, and tested formulations were prepared by Pat Dysart in the Crop Science/Weed Science laboratory/Hyslop Farm. All HPLC analyses were run by the staff in the laboratory of Dr. Fred Stevens, Principal Investigator for the Linus Pauling Institute at OSU.

Results

Objective 1

These are preliminary results and need to be repeated, so there were no statistical analyses performed. Actual dose curves will be developed after final formulations have been created.

Results showed that an aqueous western juniper extract at 15% and 25% w/v concentration was not effective as a *post-emergent* bioherbicide unless combined with standard weed control additives such as crop oils and/or non-ionic surfactants. However, when combined with 5% additives, seedling deterioration was rapid and complete for both medusahead and cheatgrass seedlings at the 2-leaf stage. Application rates of the solution were high, but since the active ingredient(s) need to be determined, no comparison can be made yet to conventional commercial herbicide field application rates. After 24 hr, the extract + juniper oil/R11 combination treatment reduced seedling vigor by 30-95%. The extract + R11 and extract + juniper oil treatments reduced seedling vigor by 30-50% during that same time, but after 1 week, all treatments produced 100% seedling mortality. Deterioration effects could be seen within 2 hours after spraying. Cheatgrass seedlings were affected more initially than medusahead, but after 1 week, no treated seedlings were alive from either species. In a small separate experiment, older seedlings sprayed with lower concentrations of just the extracts + non-ionic surfactant showed no difference versus the controls.

Objective 2

We have not yet identified the two unknown glycosides and their aglycones. This is an on-going analysis. We do not know the active toxic ingredient(s) in the raw juniper extract.

Conclusions

A natural bioherbicide made from the leaves of western juniper trees in conjunction with standard weed control additives appears to significantly suppress growth of young medusahead and cheatgrass seedlings in a post-emergent application. Application rates are high but since the active ingredient(s) of the extract are not known, and since this is not the final formulation, A.I. field application rate comparisons to commercial herbicides are not appropriate at this time. Our previous data has shown western juniper extracts are effective at suppression of seed germination as a preemergent, but now with a mixed formulation may also work as a post-emergent agent.

Development of a product like this could lead to an eco-friendly, weed control product to aid in major restoration of rangelands, could provide an excellent small business opportunity for rural areas, and encourage management of western juniper woodlands. All with the purpose in mind of restoring native forage grasses back to pastures to increase forage for domestic and wild grazing animals.

Acknowledgements

This part of our development research was financially supported by the Oregon Beef Council.

Main Cooperators in all On-Going Juniperocide Research

Dr. Fred Stevens, Principal Investigator of the Linus Pauling Institute at Oregon State University and Professor of Natural Products Chemistry; Dr. Mike Borman, Chair, Dept. of Rangeland Ecology and Mgmt; Mr. Richard Mattix, Manager, OSU Hyslop Farm Operations, Corvallis, OR.; Mr. Jason Smith, Rangeland Manager, Confederated Tribes of Warm Springs; and Mr. Marvin Butler, Superintendent Central Oregon Agricultural Research Center (COARC).

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Oregon State University

BEEF073

Beef Cattle Sciences

Oregon Beef Council Report

Revegetating Sagebrush Rangelands Invaded by Medusahead [1]

Dustin D. Johnson[2] and Kirk W. Davies[3]

Synopsis

Prescribed burning followed by imazapic application was applied to medusahead-invaded rangelands in eastern Oregon to control medusahead in preparation for testing revegetation treatments consisting of native and nonnative plant materials.

Summary

The objectives of this study are to determine: 1) effective treatments for controlling medusahead and 2) the appropriate plant materials for revegetating medusahead-invaded rangelands. Initial treatments of prescribed burning immediately followed with applications of the preemergent herbicide imazapic were applied to three 130 x 165 ft plots at each of five sites in eastern Oregon during the fall of 2010. The same treatment combination was applied to an additional 130 x 165 ft plot at each of the five sites during the fall of 2011. All burned and herbicide treated plots were seeded during the fall of 2011 with either a mix of introduced species, native species, or a combination of introduced and native species. The study also includes an untreated control plot at each of the five sites. Prescribed burning followed with an application of imazapic at a rate of 6 oz/ac substantially reduced medusahead cover and density compared to the untreated controls. Initial results suggest fall prescribed burning to remove persistent medusahead litter followed immediately with applications of imazapic at a rate of 6 oz/ac is an effective treatment combination for controlling medusahead. Revegetation success of seeded introduced and native plant materials will be reported in subsequent progress reports and a final report.

Introduction

Medusahead (*Taeniatherum caput-medusae* (L.) Nevski) is an aggressive exotic annual grass that decreases biodiversity, degrades wildlife habitat, reduces livestock forage production, and increases fine fuel loads (Davies and Svejcar 2008). Medusahead has invaded at least 5 million acres in the northern Great Basin and an additional 62 million acres are at risk of invasion. Revegetation of medusahead infested rangelands with desirable plants is needed to increase livestock forage production, improve wildlife habitat, restore biodiversity and sustain productivity of adjacent land at risk of medusahead invasion. Medusahead invasion is a particularly challenging management problem because most efforts to revegetate infested rangeland are unsuccessful (Young 1992). Short-term control of medusahead has been accomplished with various treatments. Perhaps the most promising combination of treatments for control of medusahead has been prescribed burning followed by a fall application of imazapic. Davies (2010) demonstrated that introduced perennial grasses could

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Assistant Professor, Oregon State University Extension Service, Burns 97720. Email: dustin.johnson@oregonstate.edu.
3. Rangeland Scientist, USDA-Agricultural Research Service – EOARC, Burns 97720. Email: kirk.davies@oregonstate.edu.

be successfully established after using fire-imazapic treatment to control medusahead, but treatment plots were too small (16.4 by 16.4 ft) to be applicable to large-scale management scenarios encompassing a broader range of environmental conditions. In addition, this study did not evaluate the potential use of native plants for revegetation.

Revegetating rangelands invaded by medusahead is constrained by a lack of information to assist land managers in determining 1) the best method to control medusahead and promote revegetation success and 2) the most suitable plant materials to seed after medusahead control. We propose to 1) evaluate and demonstrate the effectiveness of prescribe burning followed by imazapic application to control medusahead 2) compare the post-control revegetation success of native plants to introduced plants, 3) determine if revegetation should occur immediately or one year after medusahead control, and 4) determine if seeding a diversity of species improves revegetation success.

Materials and Methods

Five sites (blocks) in eastern Oregon invaded by medusahead with varying soils, potential natural vegetation, slope, aspect, and elevation were selected for study. Each block consisted of five 130 X 165 ft plots randomly assigned to the different treatments with a 6-ft buffer between treatments. Three of the plots were fall prescribed burned and then treated with imazapic (Plateau®) during 2010. In the fall of 2011, one year after treatment, these plots were randomly assigned to be seeded with a mix of introduced, native, or introduced-native species. Also in the fall of 2011, another plot was fall prescribed burned and treated with imazapic. This plot was immediately seeded with the introduced species mix to determine if seeding can occur without waiting one growing season after applying the preemergent herbicide imazapic. The fifth plot will serve as the control (non-treated) plot. The introduced species consisted of forage kochia, an introduced shrub that is highly palatable and nutritious, crested wheatgrass, and Siberian wheatgrass. The native seed mix consisted of Wyoming big sagebrush, bluebunch wheatgrass, and bottlebrush squirreltail. The introduced-native mix consisted of forage kochia, Wyoming big sagebrush, crested wheatgrass, Siberian wheatgrass, bluebunch wheatgrass, and bottlebrush squirreltail.

Prescribed burns were applied in late September or early October as strip-head fires ignited with drip-torches. After burning, imazapic was applied at a rate of 6 oz/acre. This rate has been used to successful control medusahead in other research projects (Davies 2010; Davies and Sheley 2011). Immediately or one year after imazapic application, depending on treatment, shrubs will be broadcast seeded and then perennial grasses will be drill seeded using a Versa-Drill (Kasco, Inc., Shelbyville, IN, USA). Species will be mixed together in equal proportions and seeded at 20 lbs/ac PLS for grasses and 3 lbs/ac PLS for shrubs. This seeding rate was found to be effective for establishing introduced perennial grasses in medusahead infestations that had been controlled with prescribed fire and herbicide application (Davies 2010).

To determine revegetation success of seeded species vegetation cover and density will be sampled for three years post-seeding (2012, 2013, and 2014). Shrub cover will be measured by species using the line-intercept method on four, 130-ft transects spaced at 16.4-ft apart. Shrub density by species will be measured using a 6.5 X 130-ft belt transects placed over the four, 130-ft transects. All shrubs rooted inside the belt transects will be counted. Herbaceous cover and density will be measured by species in 1.3 X 1.6 ft quadrats located at 13-ft intervals along the 130-ft transects, resulting in 10 quadrats per transect and 40 quadrats per treatment plot. The quadrats will be divided into 1, 5, 10, 25, and 50% segments to make cover estimation easier and more accurate. Because of the potential for adverse effects of forage sampling on relatively young seedlings, forage production and quality will be determined in the third year post-seeding. Forage biomass yield will be determined by clipping plant functional groups within 15 randomly located 10.7 ft^2 quadrats per treatment plot. Vegetation will be oven-dried, separated into current year's and previous years' growth, and weighed to determine yield. Crude protein content will be calculated by determining nitrogen content using LECO CN 2000 (LECO Corporation, St. Joseph, MI, USA) and then multiplying nitrogen content by 6.25. Crude protein of current year's growth will be determined as a percent of dry matter. An Ankom 200 fiber analyzer (Ankom Co., Fairport, NY, USA) will be used to determine ADF (Georing and Van Soest 1970) and NDF (Robertson and Van Soest 1981).

Results

Prescribed burning followed with an application of imazapic at a rate of 6 oz/ac reduced medusahead cover and density to 2 +/- 1.9% and 5 +/- 5 individuals per yd^2, respectively, the year following treatment, whereas, the untreated control plots supported medusahead cover and density values of 45 +/- 22% and 750 +/- 230 individuals per yd^2 during the summer of 2011 (Figure 1). Bare ground was 85 +/- 10% in the treated plots compared to 10 +/- 8% in the untreated control plots.

Figure 1. Example of medusahead control using fall prescribed burning followed with an application of imazapic at 6 oz/ac (left) compared to the untreated control plot (right) one year after treatment.

Conclusions

Initial results suggest fall prescribed burning followed immediately with applications of imazapic at a rate of 6 oz/ac is an effective treatment combination for controlling medusahead. Burning reduces the persistent litter layer that develops on medusahead-invaded sagebrush rangelands. Removing the litter layer prior to herbicide treatment likely serves to increase bare ground which improves soil coverage of imazapic, a preemergent, soil-active herbicide. Likely, without removing litter by burning or some other means (i.e., mechanical), the preemergent activity of imazapic on medusahead, a winter annual grass, would be greatly reduced and control success would be compromised. Prescribed burning and imazapic application also greatly reduced competition from medusahead which provided a more favorable seedbed for revegetation. Revegetation success of mixtures of introduced and native plant materials will be reported in subsequent progress reports.

Acknowledgements

This research study was financially supported by the Oregon Beef Council.

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Oregon State University

BEEF065

Beef Cattle Sciences

Oregon Beef Council Report

Grazing Behavioral Responses of Beef Cattle to Medusahead Invasion in Sagebrush Steppe Rangeland [1]

Dustin D. Johnson[2], Kirk W. Davies[3], and Reinaldo F. Cooke[4]

Synopsis

Preliminary results of a study of grazing behavioral responses of beef cattle to medusahead invasion in sagebrush steppe rangeland suggest important differences exist in nutritional quality between crested wheatgrass and medusahead during the growing season. These differences may contribute to beef cattle grazing behavior in rangelands invaded by medusahead.

Summary

The objectives of this study are to determine: 1) seasonal forage quality of medusahead-invaded rangeland relative to adjacent rangeland supporting desirable vegetation; 2) relative grazing preference of beef cattle for medusahead-invaded rangeland and adjacent rangeland supporting desirable vegetation; 3) seasonal cattle behavioral responses to medusahead invasion. Rangeland pastures (1000 to 3500 acres) in southeast Oregon containing both areas of substantial, near monotypic infestations of medusahead and areas of remnant, intact desirable vegetation (seed or native range grasses) were selected for the study. All areas (patches) principally comprised of medusahead and areas of desirable rangeland vegetation were identified and mapped in each study field during the summer of 2010. The study employed global positioning system (GPS) collars to measure seasonal behavioral responses of beef cattle to medusahead invasion. Cattle grazed the study fields continuously, season long (~April through September) to allow determination of seasonal variation in grazing behavior. Concurrent with collection of cattle behavioral information, composite forage quality samples were gathered on a biweekly schedule during the trial from five randomly selected medusahead patches and five paired areas of intact desirable rangeland vegetation (crested wheatgrass) within each study field. Forage samples were analyzed for crude protein content, acid detergent fiber, neutral detergent fiber, and total digestible nutrient content to determine relative seasonal variation in forage quality of medusahead and desirable rangeland vegetation to aid in the interpretation of cattle grazing behavior. Forage quality information from the Happy Valley site in 2010 indicated a significant separation between medusahead and crested wheatgrass in crude protein and total digestible nutrient content throughout the majority of the growing season. Variation in forage quality between medusahead and desirable rangeland vegetation may help to explain cattle grazing behavioral responses to medusahead invasion.

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Assistant Professor, Oregon State University Extension Service, Burns 97720. Email: dustin.johnson@oregonstate.edu.
3. Rangeland Scientist, USDA-Agricultural Research Service – EOARC, Burns 97720. Email: kirk.davies@oregonstate.edu.
4. Assistant Professor, Oregon State University – EOARC, Burns 97720. Email: reinaldo.cooke@oregonstate.edu.

Medusahead (*Taeniatherum caput-medusae* (L.) Nevski) is an exotic annual grass invading rangelands in the western United States (Young 1992). Medusahead is a serious management concern (Davies and Johnson 2008) because it decreases biodiversity, reduces livestock forage production, and degrades the ecological functions of native plant communities (Davies and Svejcar 2008). Medusahead invasion negatively impacts native plant communities by competition, suppression, and increasing fire frequency. Medusahead effectively competes with desirable vegetation for resources (Young and Mangold 2008). In addition, medusahead litter has a slow decomposition rate allowing it to accumulate and suppress other plants. The accumulation of medusahead litter also increases the amount and continuity of fine fuel, which can increase the frequency of wildfires to the detriment of native vegetation (Young 1992; Davies and Svejcar 2008). Similar to other exotic annual grasses, revegetation of medusahead-invaded plant communities is expensive and often unsuccessful because seeded desirable vegetation rarely establishes (Young 1992). In addition, medusahead invasion can greatly reduce the grazing capacity of rangelands (Davies and Svejcar 2008); making it clear that medusahead can create significant economic losses for landowners and ranchers.

Despite thorough documentation of the ecological impacts of medusahead (e.g., Davies and Svejcar 2008) and challenges associated with control and restoration of medusahead-invaded rangeland (Davies and Johnson 2008), little is known about the effects of invasion to cattle grazing behavior. Much anecdotal evidence exists suggesting medusahead is palatable to grazing livestock only briefly in early spring prior to development of a seed head. However, no studies have sought to document grazing preferences and behavior of beef cattle on medusahead-invaded rangeland in relation to seasonal changes in forage quality/ palatability of medusahead relative to desirable rangeland vegetation. In addition, little information is available for informing decisions about appropriate grazing management strategies for beef cattle on medusahead-infested rangeland. Quite possibly, the timing, frequency, and intensity of cattle grazing on medusahead-invaded rangeland could be managed to favor desirable rangeland vegetation and negatively impact medusahead. However, without sufficient information on seasonal grazing use of medusahead and desirable vegetation, such strategies will be difficult to realize. The objectives of this project are to 1) determine seasonal forage quality of medusahead-invaded rangeland relative to adjacent rangeland supporting desirable vegetation; 2) determine relative seasonal grazing preference of beef cattle for medusahead-invaded rangeland and adjacent rangeland supporting desirable vegetation; and 3) determine seasonal cattle behavioral responses to medusahead invasion.

Materials and Methods

Study Area

The study area is located on sagebrush steppe rangeland in southeast Oregon. Study fields (1,000 to 3,500 acres) contain both areas of substantial, near monotypic infestations of medusahead and areas of remnant, intact desirable vegetation (seed or native range grasses). Medusahead-invaded portions comprise between 10% and 20% of the study fields (Rob Sharp and Travis Miller, Bureau of Land Management Rangeland Management Specialists, *pers. comm.*). Annual precipitation in the area is 9.8 inches with 68% occurring between October and March and 23% occurring between April and June. Average maximum and minimum temperatures range between 12° and 37° F in January and 39° and 70° F during the growing season April –June.

Vegetation Mapping

All areas (patches) principally comprised of medusahead were identified and mapped in each study field during the summer and fall of 2011 using Trimble GeoXT GPS units. Concurrently, areas of predominantly desirable rangeland vegetation (either seeded or native) were identified and mapped.

GPS Collar and Forage Utilization Data

The study employed global positioning system (GPS) collars to measure seasonal behavioral responses of beef cattle to medusahead invasion. The experiment was spatially replicated in two pastures using a sub-sample of the study herd consisting of five randomly selected cow/calf pairs fitted with GPS collars. Cattle grazed the study fields continuously, season long (~April through September) to allow determination of seasonal variation in grazing behavior. Total stocking was established in the trial so as not to exceed the animal unit months (AUM) normally allotted to each study field. GPS collar data was collected in 2011 using Lotek®GPS2200 units capable of simultaneously tracking ≤ 8 satellites. GPS collars were configured

to secure records every 30 minutes from April 15th to September 30th. Each record included collar number, date, time, longitude and latitude, elevation, a dilution of precision value (an index of satellite geometry reflecting position accuracy), a 2- or 3-dimension fix status, ambient air temperature, motion sensor counts, and satellite information used for differential correction. Motion sensors in each of the GPS collars monitored the left/right and acceleration/ deceleration movements of an animal's head. These data can be used to classify and estimate durations of animal activities like grazing, resting, and traveling (Ungar et al. 2005). To accurately relate cattle activities with data acquired by the collar's motion sensors, each instrumented cow was continuously observed for at least 8 daylight hours. Activities monitored included: foraging, walking, lying, standing, drinking, and grooming. Activity time and duration were tallied by observers at a 1-min resolution. Data were compiled as the total number of minutes a cow participated in each activity during 30-min intervals. In addition to yielding time estimates of various cattle activities, this exercise allows association of cattle behaviors (e.g., grazing, loafing, grooming, etc.) with specific geographic locations, vegetation types, topographic positions, etc. within the study fields. Seasonal cattle forage preference will be characterized by overlaying vegetation mapping data with measured cattle grazing locations.

Forage Quality

Concurrent with collection of cattle behavioral information, composite forage quality samples were gathered from five randomly selected medusahead patches and five paired areas of intact desirable rangeland vegetation (crested wheatgrass) within each study field. Forage quality samples were collected on a bi-weekly schedule over the growing season. Forage samples were analyzed for crude protein content, acid detergent fiber, and neutral detergent fiber to determine relative seasonal variation in forage quality of medusahead and desirable rangeland vegetation.

Results

Vegetation mapping, forage quality, and cattle behavioral information from 2011 are still being collected, summarized, and/or analyzed at the time of writing this progress report, therefore; only forage quality and cattle behavioral information from 2010 collected in Happy Valley, OR will be described here. In addition, the sampling period in 2010 was cut short due to the livestock producer's need to move cattle from the study field in response to a diminishing forage supply prior to the end of the grazing season. Approximately 5.4%, 53.5%, and 41.2% of the study field was comprised of plant communities dominated by medusahead, crested wheatgrass, and other (primarily native) range grasses, respectively. Crude protein (CP) content of medusahead was different from crested wheatgrass across all sampling dates in 2010 (Figure 1). CP content of crested wheatgrass was approximately 1 to 3% higher than medusahead from early May through the end of June, at which time CP content of crested wheatgrass declined to below that of medusahead. Total digestible nutrient (TDN) concentrations were different between crested wheatgrass and medusahead on three of the five sampling dates early May through mid-July (Figure 2). TDN concentrations of crested wheatgrass were 3 to 4.5% higher than medusahead in May, whereas TDN was not different between the forages in June. By mid-July, the TDN concentration of crested wheatgrass had declined to well below that of medusahead. Grazing preference of beef cattle for crested wheatgrass and medusahead varied throughout the season (Figure 2). Cattle generally expressed a strong preference for grazing crested wheatgrass dominated plant communities late April through mid-June. Cattle exhibited preference for medusahead-dominated plant communities during late April, avoidance of medusahead throughout May, and preference once again by mid-June.

Conclusions

Preliminary results from the 2010 pilot study suggest important differences exist in nutritional quality between crested wheatgrass and medusahead during the growing season. These differences may contribute to beef cattle grazing behavior in rangelands invaded by medusahead. However, caution should be exercised when interpreting the observed differences in forage quality because sampling was truncated due to the cattle producer's need to move cattle from the pasture early in the grazing season. Therefore, the reported forage quality data represent only a portion of the grazing season and do not provide a clear picture of potentially important forage quality differences between crested wheatgrass and medusahead that may exist later in the season. Data from 2011 will provide a much more comprehensive analysis of the

influence of forage quality differences on cattle grazing behavior. Data from 2010 suggest cattle expressed great preference and associated selectivity for crested wheatgrass during the period of the growing season when it offered superior nutritional quality relative to medusahead-dominated plant communities. However, as the quality of crested wheatgrass declined to below that of medusahead, an apparent shift in preference to medusahead was observed, suggesting that cattle, at least in part, may be responding to a divergent nutritional status among the two plant communities over the growing season. The causes of the reversal in nutritional status of the two plant communities by early to mid-July are not clear, however, medusahead, a relatively shallow-rooted annual grass, may have responded to mid to late June light precipitation events with new growth, whereas crested wheatgrass, a deep-rooted perennial grass, was less readily able to respond to the summer precipitation. Alternatively, given the fact that cattle were moved early in grazing season in response to a diminishing forage supply, another explanation may be that cattle had preferentially grazed the current year's growth of crested wheatgrass leaving primarily previous years' residual growth of low quality behind for the final sampling periods. In this case, cattle may have been responding more to a diminishing supply of current year's growth of crested wheatgrass than an apparent shift in the quality of the two forage types. Nonetheless, preliminary results suggest cattle largely avoid grazing in patches of medusahead when their nutritional quality is substantially less than that of surrounding vegetation, which was the case throughout the majority of the growing season in 2010.

Acknowledgements

This research study was financially supported by the Oregon Beef Council.

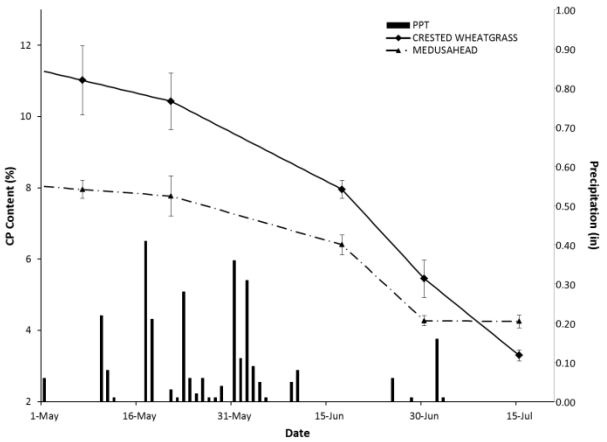

Figure 1. Crude protein content of crested wheatgrass and medusahead and daily precipitation totals from early May through mid-July at the Happy Valley study location.

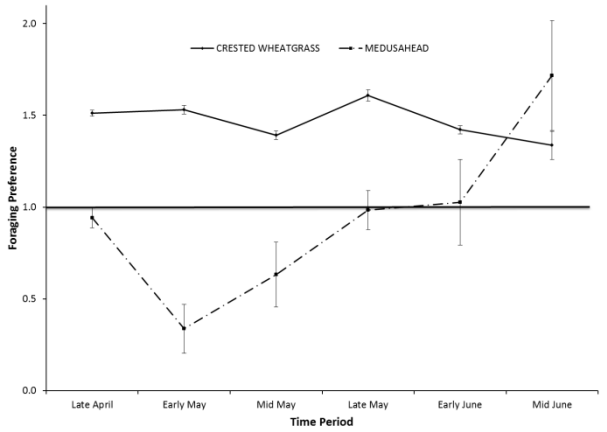

Figure 2. Foraging preference of three cows for crested wheatgrass and medusahead from late April through June at the Happy Valley study location. A foraging preference ratio greater than 1 indicates cows selected the forage type, whereas a ratio less than 1 suggests cows avoided grazing the forage type.

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Oregon State University

BEEF080

Beef Cattle Sciences

Oregon Beef Council Report

Identification of Big Sagebrush Subspecies by NTS 5S Ribosomal RNA Fractionation [1]

J. A. Perez-Amaro[2], R. Mata-Gonzalez[3], C. Boyd[4], J. Leonard[5],T. DelCurto[6], D. Bohnert[7], M. Borman[8], Y. Nieto-Carrillo[9]

Synopsis

A molecular identification method for the characterization of big sagebrush (*Artemisia tridentata*) and its subspecies is being investigated using nucleotide sequence similarities and divergences in the non-transcribed spacer (NTS) regions of the 5S rRNA gene. This is an important step to identify a DNA region for primer placement for sagebrush identification in cattle and wildlife diets.

Summary

The goal of this study was to differentiate subspecies of big sagebrush that can potentially be present in cattle and wildlife diets. For this, we evaluated the usefulness of microfluidic electrophoresis (Caliper LabChipXT(®)) to assess unique banding profiles of sagebrush plants collected in eastern Oregon. The assay combined two different steps. First, a polymerase chain reaction (PCR) amplification of genomic sequences using NTS 5S rRNA universal primers and second, determination of DNA sizing and fractionation using a LabChip XT device. Useful information was obtained through analyses of banding patterns that permitted to differentiate big sagebrush subspecies. Future research efforts will include DNA sequencing of conserved NTS 5S rRNA regions after LabChip XT excision to design sagebrush specific primers and probes. Considering the nature of NTS 5S rRNA in terms of high genetic diversity among sagebrush subspecies and its potential for analytical and quantitative studies, we recommend its use for sagebrush identification.

Introduction

Because big sagebrush is a dominant component of North American rangelands it is important to define its possible contribution to cattle diets. It is also important to identify big sagebrush subspecies because they have definite morphological and ecological differences. For example, it may be possible that cattle have a selection for a particular

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Research Assistant, OSU – Department of Rangeland Ecology and Management, Corvallis, OR 97331 Email: amaroj@onid.orst.edu.
3. Assistant Professor, OSU – Department of Rangeland Ecology and Management, Corvallis, OR 97331 Email: ricardo.matagonzalez@oregonstate.edu.
4. Rangeland Scientist, USDA, Agricultural Research Service, Burns, OR 97720. Email: chad.boyd@oregonstate.edu.
5. Research Associate, OSU - Department of Crop and Soil Sciences, Corvallis, OR 97331 Email: jeff.leonard@oregonstate.edu.
6. Professor, OSU – EAORC Union, OR 97883, Email: tim.delcurto@oregonstate.edu.
7. Associate Professor, OSU – EAORC Burns, OR 97720 Email: dave.bonhert@oregonstate.edu.
8. Department Head and Extension Specialist, OSU – Department of Rangeland Ecology and Management, Corvallis, OR 97331 Email: michael.borman@oregonstate.edu.
9. Graduate Student, Biological & Ecological Engineering, O, Corvallis, OR 97331 Email: amaroy@onid.orst.edu.

subspecies that may vary in abundance or habitat importance with respect to others. Therefore, accurate and reliable taxonomy of this plant is required. Researchers have tried to establish a reliable method to identify sagebrush subspecies based on different approaches such as ultraviolet spectrophotometry (Shumar et al., 1982), leaf shape (Brunner, 1972), chromatography (West et al., 1978), and identification of other biochemical and ecological traits. However, identification of sagebrush subspecies is often difficult and cumbersome, particularly when trying to identify sagebrush in the diet using digested material beyond morphological recognition.

We recently found that sagebrush materials present in fecal samples could be identified in a consistent and reliable manner using the melting temperature of its trnL gene sequence (Perez-Amaro et al., 2010). It is also possible to determine the proportions of dietary plant components by analyzing sagebrush and grass DNA sequences cloned within antibiotic sensitive bacteria. However, a major difficulty of cell-based DNA cloning is the general requirement for the incorporation of plant DNA into bacterial cells, which is labor intensive, and therefore expensive. Alternatively, DNA cloning and traceability of species in complex DNA mixtures can be achieved by using real-time quantitative in vitro primer-directed amplification of specific sequences of DNA (qPCR). In this regard, advances in molecular identification have established that plant identification of different species in mixtures can be possible using specific primers developed from NTS 5S rRNA (Ko and Henry, 1996; Luciano et al., 2007). The coding region of the 5S rRNA gene is highly conserved, but its spacers (NTS) are variable among species and can be used for identification purposes (Bertea et al., 2006). Thus in the current study, we aimed to identify and characterize polymorphic bands that distinguish sagebrush subspecies. In a subsequent phase, partial NTS 5S rRNA genomic regions, whose DNA sequence is unique and conserved in all sagebrush plants, will be used to design sagebrush-specific primers for their potential use in qPCR applications. This is an essential phase to quantify proportions of plant species in herbivore diets.

Materials and Methods

Reference sagebrush plant materials were collected at sites in eastern Oregon and stored in plastic bags at -80 ºC. Morphological characters of persistent overwintering leaves were used to classify the reference collection. Three different subspecies of big sagebrush were identified and collected: subspecies *tridentata*, subspecies *vaseyana*, and subspecies *wyomingensis*. For identification purposes, low sagebrush (*Artemisia arbuscula*), another important sagebrush plant in the genus *Artemisia*, was also included in the analysis. As plant controls for DNA identification via banding pattern comparison (fingerprint patters), we analyzed other closely related shrubs of the Asteraceae family that usually inhabit big sagebrush communities: rubber rabbitbrush (*Ericameria nauseosa*) and green rabbitbrush (*Chrysothamnus viscidiflorus*). In addition, we included an unrelated species, Italian ryegrass (*Lolium perenne*), as additional control for more data amplitude.

Plant DNA extraction

DNA was extracted from three different plants of each species or subspecies to evaluate their genetic variation using a DNA plant kit (the DNeasy plant mini kit from Qiagen). Briefly, 0.2 g of young leaves were reduce to fine particles with liquid nitrogen, lysed and purified by a series of steps to remove proteins and polysaccharides according to the manufacturer's instructions and finally eluted in 50 µl of elution buffer to increase the final DNA concentration. Extracted DNA was quantified and diluted 10 to 1,000 fold; bovine serum albumin was included as part of the elution buffer to lessen downstream PCR inhibition.

PCR DNA fingerprinting and analysis

A portion of genetic material, the NTS 5S rRNA gene of sagebrush plants was amplified by a polymerase chain reaction (PCR with a primer set of tailed universal primers). The PCR reaction was carried out in a final reaction volume of 25 µl using the Hot Start Taq Master Mix (Qiagen) from 50 ng of DNA as template. The mixture reaction included 1X PCR buffer, 2.5 U of Qiagen Hot Start Taq, 0.2 mM of each dNTP and 1µM of each primer.

The PCR was performed in a Thermoblock using a touchdown approach with the following thermal cycling parameters: activation step of 94 ºC for 15 min, followed by 5 cycles each of denaturation of 94 ºC for 30 s, annealing of 65 ºC for 30 s and extension of 72 ºC for 30 s. This was followed by 30 cycles each of 94 ºC for 30 s, annealing at variable temperatures for 30 s, and 72 ºC for 30 s. In the first cycle, the starting annealing temperature was set to 60 C, and for each of the

following 29 cycles the annealing temperature was decreased by 1 C (Annealing temperature range from 60 ºC to 30 ºC). A final extension time of 5 min at 72 ºC was set. PCR amplification was first visualized in a gel electrophoresis to verify product size and the product quantified with a Qubit® fluorometer. Subsequently, DNA amplicons were size fractionated by microfluidics chip in a LabChip XT device using all the controls provided in the Assay Kit from the manufacturers. Amplicons on each subspecies were collected on the same device for further sequencing analysis. Electropherograms were automatically generated with the LabChip XT software for interpretation and visualization of amplicons.

Results

By examining obtained profiles of the NTS 5S rRNA amplicons, one can tell whether an unidentified plant material belongs to a particular species or subspecies. For instance, a common amplicon of similar size (155 bp ± 10 bp) appeared for all the species and subspecies of *Artemisia*, which indicates a conceivable conservation region as well as a possible ancestor among species of big and low sagebrush. In addition, the NTS 5S rRNA sequences of big sagebrush subspecies were distinct from that of closely related shrubs (rabbitbrush species) and the grass controls (Fig. 1). The three subspecies of sagebrush have similar major PCR products. Nevertheless, the determinant amplicon in assessing the subspecies characterization was an amplicon of either bigger size than the most prevalent one (150 bp) or the absence of it, since it varied on each plant subspecies. In order to determine the exact size of the amplicons in sagebrush subspecies, a LabChip XT electropherogram was generated (Fig. 2). By using this technique, it was possible to calculate PCR fragment sizes, and number of products in more detail without the need of chemically modified oligonucleotides. The electropherogram patterns of sagebrush species and subspecies show clear differences that make easier to appreciate the differences observed in the agarose gel results presented here. All electropherograms of sagebrush plants show two major fractions or peaks, and sometimes some small peaks in between can also be found. To demonstrate, subspecies *tridentata* amplifies a fragment of 344 bp while subspecies *vaseyana* presents an amplicon of 494 bp. Subspecies *wyomingensis*, however, does not display consistently both peaks (Fig. 2). Agarose gel electrophoresis (Fig. 1) revealed at first sight that there was no apparent difference in the amplicon size distribution and number between subspecies *wyomingensis* and *Artemisia arbuscula* (low sagebrush). However, with Caliper's LabChip XT, the subspecies *wyomingensis* peak patterns are quite dissimilar to those displayed by low sagebrush. As indicated by electropherogram analysis (Fig. 2), low sagebrush has also two amplicons of similar size (223 bp and 155 bp), which in an agarose gel are not easy to distinguish.

Conclusions

The LabChip XT system is a relatively new technology that can aid in the identification of sagebrush plants. In this study it was easy to operate and it had a high level of reproducibility. These features make the LabChip XT system combined with the NTS 5S rRNA gene of big sagebrush a promising tool to analyze and identify subspecies of big sagebrush. In addition, PCR products can potentially be excised from different barcoded fecal samples, and converted into sequencing libraries for ultra-high-throughput sequencing. This is theoretically possible using the highly sensitive, fast response, low cost 454 pyrosequencing, which can handle numerous samples in a single multiplex run.

Acknowledgements

The authors are most grateful to Anne-Marie Girard, Caprice Rosato (Center for Genome Research and Biocomputing (OSU-CGRB)), and William Beckwith (Caliper Life Sciences) for the opportunity to use the Caliper LabChipXT®. The names of any commercial manufacturers are provided for information only and do not imply an endorsement by any of the authors. This work was supported by grants from the Oregon Beef Council, and from CONACyT (The Mexican National Council for Science and Technology) through PhD scholarship number 162606.

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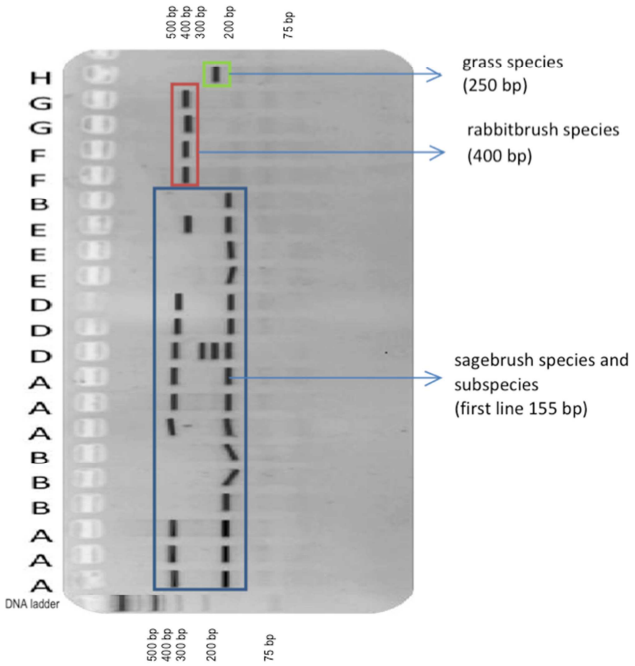

Figure. 1. Amplification of the NTS 5S rRNA gene region used to differentiate plant species and subspecies. Amplification products from: (A) *Artemisia tridentata* subspecies *tridentata* (basin big sagebrush); (B) *Artemisia arbuscula* (gray low sagebrush); (D) *Artemisia tridentata* subspecies *vaseyana* (mountain big sagebrush); (E) *Artemisia tridentata* subspecies *wyomingensis* (wyoming big sagebrush); (F) *Ericameria nauseosa* (rubber rabbitbrush); (G) *Chrysothamnus viscidiflorus* (green rabbitbrush), and (H) *Lolium perenne* (Italian ryegrass). Electrophoresis on 1.0% agarose gel of polymerase chain reaction products. First line 1kb Plus DNA ladder. Molecular weights of PCR products are indicated by right side arrows in base pairs (bp). The electrophoresis was conducted for 1 h at 130 V. The amount of DNA loaded per lane was 60 ng and the gel was ethidium bromide stained.

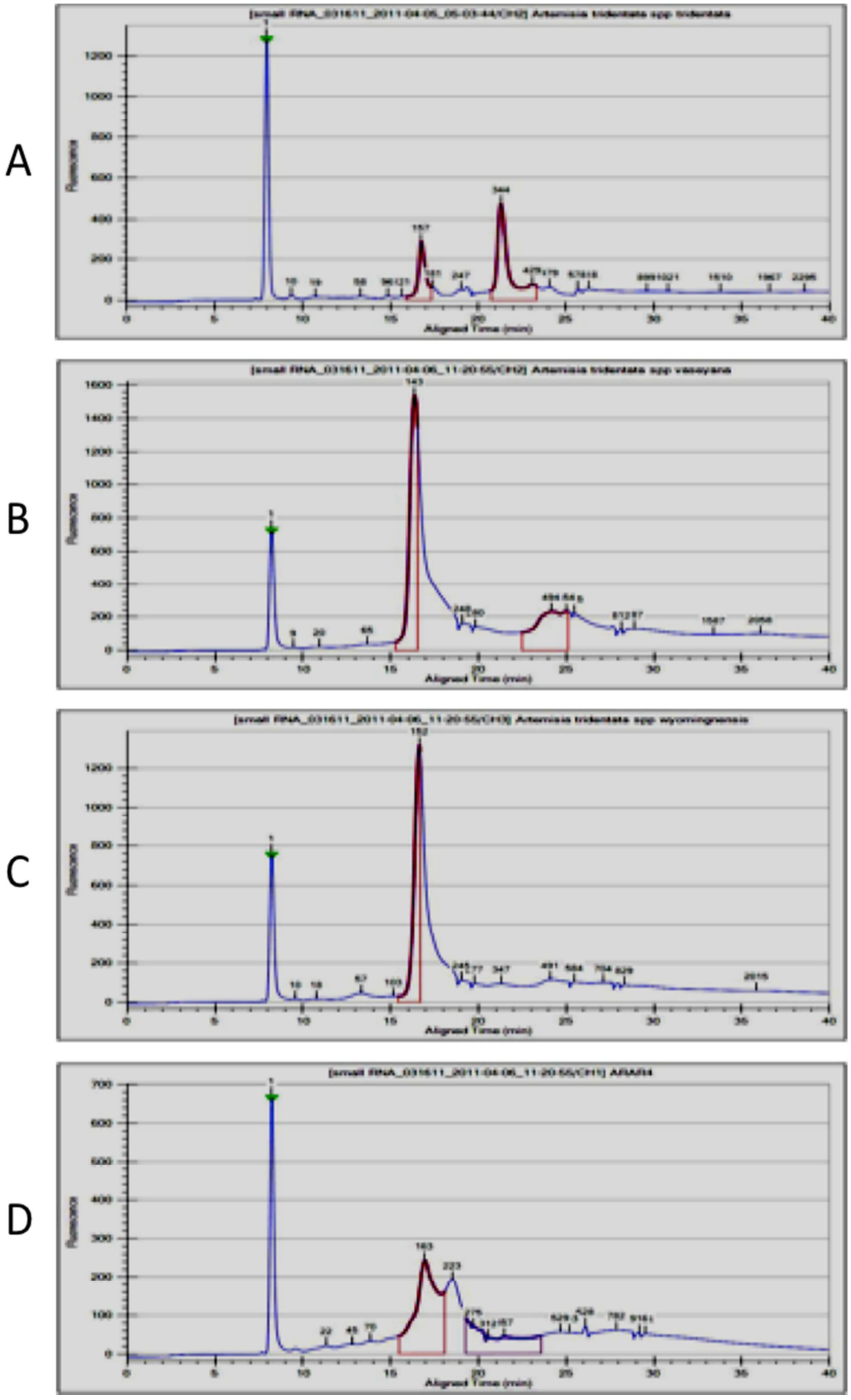

Figure 2. Caliper's LabChip XT was run in order to calculate the average size distribution, and banding profile of *Artemisia* NTS 5S RNA amplicons. Electropherograms showing amplification products from: (A) *Artemisia tridentata* subspecies *tridentata* (basin big sagebrush); (B) *Artemisia tridentata* subspecies *vaseyana* (mountain big sagebrush); (C) *Artemisia tridentata* subspecies *wyomingensis* (wyoming big sagebrush); (D) *Artemisia arbuscula* (gray low sagebrush).

Oregon State University

BEEF064

Beef Cattle Sciences

Oregon Beef Council Report

Distribution and Behavior of Cattle Grazing Riparian Pastures [1]

M.A. Wilson[2], K.D. Wilson[3], L.L Larson[4], D.E. Johnson[5], J. Williams[6] and P.E. Clark[7]

Synopsis

The distribution and behavior of cattle grazing three riparian pastures was investigated in northeastern Oregon using one second Global Positioning System (GPS) collars. Time spent by cattle in the channel, on stream banks and in vegetative communities was quantified as well as the movement behavior within each community.

Summary

The objective of this study was to determine channel and stream bank occupancy by cattle as compared to the other areas of the pasture and the preference and movement behavior expressed by cattle toward different vegetative communities within each pasture. One second GPS collars were deployed on cattle in three different riparian pastures at separate times during the year.

In all three pastures the cattle did not move evenly throughout the pastures. Cattle preferred to rest in areas that were dry and open. Cattle were stationary for more than 50% of the time in each pasture and consistently rested between dark and 4:00 a.m. Stationary locations (stationary > 10 minutes) were distributed throughout selected communities.

Interaction with the stream was found to be 1-2% of total occupancy. Cattle were either neutral in preference or avoided these areas relative to their acreage and a majority of the time spent in these areas was spent moving not resting. Cattle did not prefer to be in the stream bank zone (16 ft on the outside of both stream banks) in any pasture. The stream bank zone was used primarily as a travel corridor to get to and from the stream to drink or cross.

Introduction

Management of riparian systems in the western United States has and continues to be the subject of environmental controversy. In the arid west a significant portion of rural economies is dependent on the water and forage derived from these systems. Conversely, environmental concerns about the management of these lands and the potential impact on endangered species have placed these lands under increased scrutiny. A literature review of this subject by the National Research Council (2002) indicated that:
"Traditional agriculture is probably the largest contributor to the decline of riparian areas…" and *"The primary effects of livestock grazing include removal and trampling of vegetation, compaction of*

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Graduate Student, Oregon State University. Email: wilsmari@onid.orst.edu.
3. Graduate Student, Oregon State University. Email: wilsoker@onid.orst.edu
4. Professor, Dept. of Rangeland Ecology & Management, Oregon State University. Email: llarson@eou.edu
5. Professor, Dept. of Rangeland Ecology & Management, Oregon State University. Email: douglas.e.johnson@oregonstate.edu.
6. Associate Professor, OSU Extension, Wallowa County. Email: john.williams1@oregonstate.edu.
7. Rangeland Scientist, USDA/ARS NW Watershed Research Center, Boise Idaho: Email: pat.clark@ars.usda.gov.

underlying soils, and dispersal of exotic plant species and pathogens. Grazing can also alter both hydrologic and fire disturbance regimes, accelerate erosion, and reduce plant or animal reproductive success and/or establishment of plants. Long-term cumulative effects of domestic livestock grazing involve changes in the structure, composition, and productivity of plants and animals at community, ecosystem, and landscape scales."

However, other authors (Bryant 1982, Gillen et al. 1984, Roath and Krueger 1982, Kauffman et al. 1983, Wagnon 1968, Laliberte et al. 2001, Buckhouse et al. 1981, Ballard 1999, Wilson 2010) report research results that indicate that cattle can graze rangelands containing riparian areas without harming these riparian areas and that managed grazing can maintain and improve riparian systems.

In the middle of this controversy cattle research in riparian areas has been evolving with improved technology. Collar tracking systems began using a combination of observation and telemetry in the1950s and 1960s and more recently Global Positioning Systems (GPS) to track animal movement. These collars have the ability to track cattle movement every second, allowing the researcher to know exactly where cattle are without disturbing them. The purpose of this study was to develop a data set of cattle movement in riparian pastures using the one second collar technology to help sort through the confusion of what cattle do or do not do in these riparian systems.

Materials and Methods

Study Area

The riparian pastures used in this study are located in the Blue Mountain Province of northeastern Oregon (Anderson et al. 1998). Precipitation within the province occurs primarily as snow between November and March. The Catherine Creek pasture is a 130 acres pasture unit located on the Hall Ranch of the Eastern Oregon Agriculture Research Center (EOARC) 9 miles southeast of Union, Oregon. Catherine Creek runs for 1.2 miles through the pasture and it can be 3 ft deep and approximately 82 ft wide. Cattle typically graze this pasture in mid August and stay until early October. The primary vegetation communities in the unit include riparian shrub, dry meadow, hawthorne and pine community types. The Milk creek pasture is adjacent to the Catherine creek pasture and also contains 130 acres. Cattle typically enter this pasture in early October and stay into November. Milk Creek averages 7 ft wide and less than 3 ft deep and runs through the pasture for approximately 1 mile. The dominant vegetation communities of Milk Creek include wet, moist and dry meadow communities as well as upland communities of ponderosa pine. The North Powder pasture contains 195 acres in Baker County in northeastern Oregon. Cattle typically enter the pasture in mid July and stay throughout the summer months. The Powder River flows through the pasture for approximately 1.2 miles and averages 33 ft wide and over 3 ft deep. The major vegetation communities in the North Powder pasture include willow, baltic rush, quackgrass and saltgrass community types.

Pastures were delineated using aerial photography that was taken on 17 September 2009. Aerial images were acquired at high resolution (≈ 8 inch by 8 inch ground pixel size or 1:706 scale) using a Canon EOS Rebel XSi 12.4 megapixel digital conventional color camera mounted in the belly of a Cessna 182 aircraft. Images were corrected for lens curvature and geographically registered to USDA National Agriculture Imagery Program (NAIP) 2009 imagery. Pasture mosaics were made that show vegetative communities and stream position. The GIS layers for vegetative communities, stream boundaries and fences in each pasture were field verified using a handheld GPS. All pasture data layers (aerial photographs, vegetation, stream and boundaries) were entered into a GIS database for use in ArcGIS 10 (ESRI 2010).

Animals and GPS Collars

Ten randomly selected cows were collared for each of the three riparian pastures designated for the study. In each pasture, two sequential trials of six days were conducted because GPS data loggers record for approximately 6.25 days on a set of batteries. After the first half of the trial cattle were gathered, collar batteries and secure digital cards replaced, and cattle were returned to the pasture for another six days (2nd half). Upon completion of the second trial cattle were gathered and collars removed. Thus, each collared cow had the potential for 12 days of track logging per pasture per year.

Collars collect latitude, longitude, elevation, GPS date/time, velocity, bearing, number of satellites used for the positional fix and fix quality on a 1-second interval. Data points before the cattle entered the pasture were removed from the data set. Only days with complete data sets (98% of the day recorded) were used in this analysis.

Data retrieved from the collars were converted into ASCII text format that could be read into Microsoft® Excel® and ESRI® ArcMap® and split the data into 24 hour periods. To make an even data set, five cattle were merged into herd by day shapefiles for 10 days in each pasture each year. The Animal Movement Classification Tool (Johnson et al. 2009) was used to determine if the cattle preferred to be stationary or moving (> 0.001 kph for more than 3 consecutive seconds) in each community. Stationary positions (those with 0 velocity for 10 minutes or longer) were located by a central point.

Descriptive statistics in the form of percentages, averages and totals were used to describe the pattern of animal occupancy and activity. Relative preference indices (RPI), where appropriate, were utilized to assist in the description of animal preference. Chi-square assessments ($p < 0.05$) of occupancy and activity differences were used to verify the statistical importance of mathematical differences (Snedecor and Cochran, 1973).

Results

Cattle spent at least 50% of their time being stationary. In this study, the amount of time resting was similar regardless of pasture location, time of year or differences among cattle. Cattle tended to bed down around dark and remain relatively still until about 4:00 a.m. PST (Figure 1). By contrast, daytime resting periods occurred throughout the day, but did not follow an established pattern. Daytime resting generally appeared to be influenced by factors such as thermal conditions, weather, pasture topography and vegetation, grazing locations and individual cattle preference.

Cattle tended to prefer resting locations in the drier community types. In general these locations reflect shared characteristics of good visibility, higher (drier) elevation and deeper soil. It is assumed that these attributes provide comfort against predation and insects and favorable bedding. Although the cattle preferred to be stationary in these communities they also tended to begin grazing periods in these same areas. Some stationary locations were observed around trees but tended to occur on the edge of an open community.
The dry meadow communities were selected in all pastures for both grazing and resting activities. The hawthorne and willow communities that had sufficient soil and moisture characteristics to support palatable understory vegetation were also preferred in all pastures for grazing activity. Cattle in these communities preferred to be moving (average of 0.5 mph) or were neutral in their preference suggesting that grazing was occurring. Shrub height was well passed the grazing height of cattle in all pastures. The preference for grazing these areas appeared to be related to the greenness of vegetation found beneath the shrubs. By contrast, the dry pine communities studied in the Milk Creek and Catherine Creek pastures were strongly avoided and used primarily for resting. Vegetation beneath these shaded areas are drier and loose greenness earlier in the growing season. Preference for the vegetative communities, channel and stream bank zone is located in Tables 1, 2 and 3.

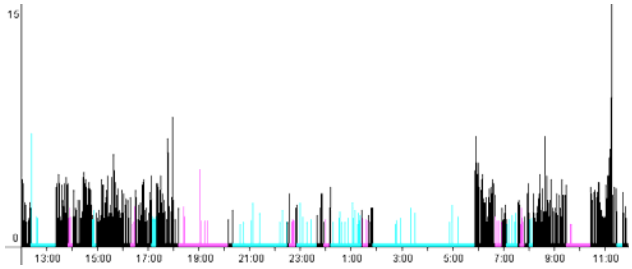

Figure 1. An example of a typical day of a cow in the Milk Creek pasture. The x axis is the time in Pacific Standard Time (PST) using military time. The y axis is in kilometer per hours. Resting locations are the pink and blue lines, done only to differentiate between resting periods. Velocity shown in the resting periods is GPS error that occurs when the unit is not moving.

Cattle tended to be indifferent or avoided the channel area of pastures. Overall cattle spent 1-2% of their time within the channel area. Most of this time was dedicated to drinking or crossing the stream. The amount of time drinking was approximately 3-4 minutes/event. Cattle avoided stream areas as resting locations and selected stream crossings where the stream banks were gently sloped, avoiding channel areas with steep banks and deeper channel water. This selection process resulted in cattle accessing less than 10% of the channel length in all pastures.

Cattle spent a minimal amount of time (2%) in the bank buffer zone that was 16 ft on the outside of both banks of the channel and consistently had no preference for this zone. These areas were used primarily as travel corridors to get to the stream for water or to reach a crossing location. The cattle occupancy data indicate that cattle do not prefer theses areas.

Table 1. Summary of cattle activities within the community types identified in the Milk Creek pasture. Designation of No and Yes by community in the preference column indicate significance (P < 0.05). NS indicates non significance.

Milk Creek		
Community	Preference	Relative Preference Index
Channel	NS	0.9
Bank (5 m)	No	1
Wet Meadow	Yes	1.6
Moist Meadow	Yes	1.7
Dry Meadow	Yes	1.5
Wet/Moist Meadow	NS	0.8
Wet/Moist Meadow w/ Hawthorne	Yes	1.4
Pine/Wheatgrass	No	0.4
Pine/Rye	No	0.2

Table 2. Summary of cattle activities within the community types identified in the North Powder pasture. Designation of No and Yes by community in the preference column indicate significance (P<0.05). NS indicates non significance.

North Powder		
Community	Preference	Relative Preference Index
Channel	No	0.4
Bank (5 m)	No	1.6
Willow	Yes	4.2
Baltic	No	0.2
Saltgrass	Yes	1.5
Small Channel	No	0.4
Quackgrass	NS	0.7
Complex	NS	1.0

Conclusions

Throughout the two year study we found that cattle do prefer certain communities over others and are either neutral in preference or avoid the channel and stream bank. These results are in contrast with the general belief that cattle are a primary occupant of the stream bank and channel and a source of significant bank alteration. This discrepancy indicates that additional research needs to be undertaken to determine if the indirect measures currently being used to measure cattle impact on bank alteration are providing an accurate measure of cattle contribution.

Table 3. Summary of cattle activities within the community types identified in the Catherine Creek pasture. Designation of No or Yes by community in the preference column indicate significance (P≤0.05). NS indicates non significance.

Catherine Creek		
Community	Preference	Relative Preference Index
Channel	No	0.2
Bank (5 m)	No	0.4
Dry Meadow	Yes	3.3
Hawthorne Baltic	Yes	2.8
Hawthorne Dry	NS	1.1
Pine	No	0.2
Riparian Shrub	No	0.5

Acknowledgements

This research was financially supported by the Oregon Beef Council. We would also like to thank the private land cooperators and the staff of Eastern Oregon Agriculture Research Center whose time and resources contributed to the completion of this study.

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Oregon State University

BEEF063

Beef Cattle Sciences

Oregon Beef Council Report

Landscape Occupancy by Free Ranging Cattle in Northeast Oregon [1]

K.D. Wilson[2], M.A. Wilson[3], L.L. Larson[4], D.E. Johnson[5], J. Williams[6] and P.E. Clark[7]

Synopsis

The occupancy of free ranging cattle was studied in Northeast Oregon from April 2008 to October 2009 to determine preference of cattle use of slopes, vegetative communities, stream use and cattle dispersion. This study is a part of the 10 year study; Evaluation of Wolf Impacts on Cattle Productivity and Behavior.

Summary

Global Positioning System and Geographic Information System technologies were employed to evaluate cattle occupancy of three landscape attributes on different grazing allotments. Topographic characteristics, vegetation over-story and occupancy of zones around perennial streams was analyzed. An appraisal of total landscape occupancy for each allotment was performed by individual animal and by animal sets as an evaluation of the home range concept as applied to managed domestic cattle.

Cattle preferred slopes <12%, did not avoid slopes 12-35% but did avoid slopes >35%. Cattle were indifferent to north and south aspects. In site 1 mixed conifer was avoided while the pine/fir and upland grass were equally preferred. Cattle in site 2 and 3 preferred the mixed conifer. In site 2 they strongly avoided the pine/fir and upland grass while only moderately avoiding these same communities in site 3. Cattle in site 1 and 3 were indifferent to all stream zones. In site 2 cattle preferred stream zones out to 90 ft. However, cattle occupied the aquatic habitat zone (0-30 ft) <1% in all sites.

Introduction

Decades of study on the distribution of cattle on rangelands has led to a large accumulation of knowledge connecting environmental factors to cattle behavior while grazing in rugged terrain typical of forested public lands. However much of our understanding of these relationships was acquired in the absence of the gray wolf. It is anticipated that introduction of gray wolf predation will impact our understanding of the hierarchal choices foraging animals routinely make while grazing rangelands.

The successful establishment and subsequent growth of the gray wolf population within the Yellowstone and Central Idaho ecosystems has led to the migration of the species into adjoining areas where they interface with domestic livestock. Increased predation on domestic

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.
2. Graduate Student, Oregon State University. Email: wilsoker@onid.orst.edu.
3. Graduate Student, Oregon State University. Email: wilsmari@onid.orst.edu.
4. Professor, Dept. of Rangeland Ecology & Management, Oregon State University. Email: llarson@eou.edu
5. Professor, Dept. of Rangeland Ecology & Management, Oregon State University. Email: douglas.e.johnson@oregonstate.edu.
6. Associate Professor, OSU Extension, Wallowa County. Email: john.williams1@oregonstate.edu.
7. Rangeland Scientist, USDA/ARS NW Watershed Research Center, Boise Idaho: Email: pat.clark@ars.usda.gov.

animals represents an obvious direct financial loss to the livestock industry and associated communities.

Little is known of the potential change in spatial and temporal activities of livestock on rangeland that come in contact with the new apex predator. It has been speculated in a recent vegetation case study within the greater Yellowstone ecosystem that the inclusion of the wolf may encourage improvement in ecological condition of riparian ecosystems through reduction of use by large ungulates in these sensitive areas. Unfortunately, these speculations are based on minimal data and provide little insight into the relationships that wolf packs may have on managed public lands designated for multiple-use.

Establishment of the gray wolf into Northeastern Oregon is anticipated and provided a window of opportunity to contrast livestock activity in areas with high wolf incidence to areas with little to no wolf presence. A ten year study was initiated in 2008 with cooperation between Oregon State University (OSU), the Agriculture Research Service (ARS) and the University of Idaho (UI). Information contained in this report relates to cattle behavior and landscape use on areas of no wolf/ low density wolf occurrence. The phrase no wolf/low wolf occurrence means zero to transient evidence of wolf occurrence as documented by the absence of wolf scat, Rancher observation of wolf predation and the lack of official statements by Oregon Department of Fish and Wildlife documenting wolf activity in the study areas. The study encompasses two grazing seasons and describes landscape use relative to topography, vegetation and perennial stream use as a water source for free ranging cattle in Northeast Oregon. Specifically, the objectives of this study are:

1. Develop landscape attributes maps appropriate for analysis of animal GPS locations.
2. Analyze GPS locations with specific questions relative to landscape attributes.
3. Evaluate and summarize results of GPS queries to suggest animal behavior.

Materials and Methods

The study area was located within the Wallowa Whitman National Forest and contains three active grazing allotments totaling 108,655 acres (43,972 hectares). Study Site 1 has an elevation gradient of 3,608ft to 8,285ft and is dominated with slopes 12-35%. Site 2 ranges in elevation from 3,113ft to 5,655ft with a significant proportion of the landscape at slopes less than 12%. Study area 3 is different from sites 1 and 2 having an elevation range from 2414 to 5245ft, with the greatest portion of land area classified with the > 35% slope designation. The 0-4% area percentage is similar to site 2.

In 2008 and 2009 ten mature beef cows with calf were randomly selected from each allotment herd and were collared with the Clark Animal Tracking System (Clark et al. 2006) prior to the herd moving into the grazing unit. The cattle were otherwise left alone by researchers during the season long trial to interact with their environment in the way ranch and agency personnel administer and carry out the spatial and temporal design of grazing use within the respective study sites.

Global Information System (GIS) maps were collected or generated for the study area to delineate the landscape attributes of slope (0-4%, 4-12%, 12-35% and >35%), aspect (north versus south), elevation, vegetation type (ponderosa pine/Douglas fir (pine/fir), mixed conifer and upland grass) and perennial stream occurrence. Occupancy of the area around perennial streams was additionally analyzed using buffer zones of 0 – 33 ft, 33 – 66 ft, 66 - 99 ft, 99 – 132 ft, 132 – 164 ft and 164 – 197 ft on both sides of the watercourse. The appraisal of landscape occupancy for each allotment was performed using individual sample animals and animal sets to evaluate the home range of managed domestic cattle.

The two year study deployed 60 collars and yielded 1,719,181 GPS locations that were used in the subsequent analyses. Descriptive statistics of average, percentage and standard deviation are reported where they relate to the question posed for the analysis of the attribute. Relative preference indices (RPI) were generated when area occupancy relative to the study site area was determined. The numerical importance of the RPI differences was verified through Chi-square assessment ($p < 0.05$) of attribute category differences (Snedecor and Cochran, 1973).

Results

In all allotments, cattle preferred slopes less than 12%, were indifferent toward slopes between 12 and 35% and avoided slopes greater than 35% (Table 1). Cattle showed no preference toward north or south aspects.

Cattle occupancy of vegetation was variable among allotments. In study area 1 mixed conifer was avoided while the pine/fir and upland grass were preferred. Cattle in study area 2 preferred the mixed

Table 1. Study area topographic and occupancy values.

Site 1 (08/09)						
Attribute	0 - 4%	4 - 12%	12 - 35%	> 35%	North	South
%Occupied	6.51	27.13	54.25	12.11	38.70	61.19
Area %	2.85	14.14	53.69	29.32	43.61	56.27
RPI	2.28	1.92	1.01	0.41	0.89	1.09
Site 2 (08/09)						
Attribute	0 - 4%	4 - 12%	12 - 35%	> 35%	North	South
%Occupied	7.40	30.52	49.72	12.36	40.38	59.53
Area %	3.88	18.42	50.03	27.68	45.31	54.62
RPI	1.91	1.66	0.99	0.45	0.89	1.09
Site 3 (09)						
Attribute	0 - 4%	4 - 12%	12 - 35%	> 35%	North	South
%Occupied	13.83	34.73	39.30	12.14	52.37	47.49
Area %	3.91	10.91	22.27	62.91	52.21	47.70
RPI	3.54	3.18	1.76	0.19	1.00	1.00

conifer avoiding areas of pine/fir and upland grass. In study site 3 cattle also preferred mixed conifer and displayed moderate avoidance toward upland grass and pine/fir (Table 2).

Evaluation of riparian buffer zones determined that cattle in site 1 and 3 were indifferent to all zones, demonstrating equal dispersion throughout. In site 2 cattle preferred the first 99 ft adjacent to perennial streams over areas 99 to 197 ft away from water. In all study sites, cattle occupied areas beyond 197 ft between 96 and 98 percent of the time and the aquatic habitat including the immediate buffer zone (0 – 33 ft) less than 1% of the time (Table 3).

Total landscape occupancy was variable between allotments. Individual animal averages were 40 to 50% less per year in site 1 compared to study area 2. Variation between animals was also less in area 1 compared to area 2. Results from site 3 analysis were limited to data from a single year (Table 4).

Table 2. Study site vegetation community and occupancy values.

Site 1 (08/09)			
Attribute	Upland Grass	P. Pine/D. Fir	Mixed Con
% Occupied	8.80	37.64	53.56
Area %	6.48	26.95	66.57
RPI	1.36	1.40	0.80
Site 2 (08/09)			
Attribute	Upland Grass	P. Pine/D. Fir	Mixed Con
% Occupied	5.66	24.46	69.88
Area %	14.38	40.92	44.69
RPI	0.39	0.60	1.56
Site 3 (09)			
Attribute	Upland Grass	P. Pine/D. Fir	Mixed Con
% Occupied	35.59	24.30	40.11
Area %	43.95	28.77	27.27
RPI	0.81	0.84	1.47

Conclusions

The objective of this research was to evaluate with GPS and GIS technologies the distribution of cattle in commercial grazing operations under conditions of low to no wolf impact. In the short term, the information reported above is designed to contribute toward current allotment administration. In the long term, these same data sets will serve as a baseline for the detection of changes in landscape usage due to the anti-predator responses being exhibited by cattle as predation levels increase.

Analysis of the occupancy of topographic landscapes in this study substantiated a number of past evaluations of how landscape features influence decisions made by cattle under present conditions. The data demonstrated that cattle largely favored slopes of less than 12% regardless of the area studied. Cattle were indifferent to steeper landscapes up to 35% using them in proportion to their area. This lack of overall variation in slope use testifies to the influence of this factor in controlling cattle distribution.

The vegetation analysis determined that mixed conifer was preferred in site 2 and 3 over that of the pine/fir and upland grass while in site 1 the upland grass and pine/fir were preferred over mixed conifer. It is not known why these differences occurred but elevation and slope likely influenced the greenness of forage at different times of the grazing season. In addition the relative size of the mixed confer area in site 1 may have influenced the preference levels being exhibited by cattle.

Analysis of the riparian buffer zone around perennial streams was the most illuminating of all the attributes analyzed. It was found that in site 1 and 3, where streams are topographically confined

and express minimal (area) riparian wetland development; cattle did not have a preference for any of the distance categories established. In other words, the defined zones had near equivalent dispersion over the area evaluated. In site 2, where streams were less confined and the area of flood plain/wetland development was greater, cattle exhibited preference toward the first 99 ft adjacent to the stream over the area between 99 and 197 ft. However, regardless of these differences cattle did not use the area around perennial water more than upland areas. Cattle were found on areas beyond 197 ft of the stream 96 to almost 99 percent of the time.

It appears that restricting topography may also reduce the area occupied by individuals and increase the degree of occupation overlap. For example in site 2 where flatter terrain predominates, cattle covered over 30% more area compared to site 1.

This type of occupancy analysis of the landscape may be of importance to land and ranch managers in the future to identify areas of concentrated occupancy in extensive environments. For example in this study it was determined that although it is commonly believed that cattle spend most of their time in perennial stream corridors the position data demonstrated that they actually spend most of their time occupying uplands. Similarly these techniques could assist in identifying areas of little to no use for targeted evaluation to increase the effectiveness of range improvement projects.

Acknowledgements

The authors acknowledge the Oregon Beef Council, Oregon State University, Oregon Agricultural Experiment Station, University of Idaho, University of California/Santa Barbara, the USDA Agricultural Research Service, USDA National Institute of Food and Agriculture, Agriculture and Food Research Initiative, and Cooperating Ranches and ranch families for funding and support. The mention of product names or corporations is for the convenience of the reader and does not constitute an official endorsement or approval by Oregon Beef Council, US Department of Agriculture, Agricultural Research Service, Oregon State University, the Oregon Agricultural Experiment Station, UC/Santa Barbara, or the University of Idaho of any product or service to the exclusion of others that may be suitable.

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Table 3. Stream area occupancy for the buffer zones of the three study sites.

Stream Area Occupancy	Percent occupied in buffer zone			Cumulative percent occupied 0-60m		
	Site 1 (08/09)	**Site 2 (08/09)**	**Site 3 (09)**	**Site 1 (08/09)**	**Site 2 (08/09)**	**Site 3 (09)**
Buffer Zones	%	%	%	%	%	%
0m-10m (Aquatic Habitat)	0.18	0.86	0.19	0.18	0.86	0.19
10m-20m	0.20	0.88	0.20	0.39	1.74	0.39
20m-30m	0.21	0.68	0.21	0.59	2.43	0.60
30m-40m	0.18	0.53	0.19	0.78	2.96	0.79
40m-50m	0.17	0.43	0.19	0.95	3.39	0.98
50m-60m	0.17	0.34	0.19	1.11	3.73	1.17

Table 4. Percent area values of polygons of 95% isopleths representing sample animal occupancy.

Landscape occupancy Analysis	Percent occupancy at 95% of GPS locations				
	Site 1		**Site 2**		**Site 3**
	2008	**2009**	**2008**	**2009**	**2009**
Sample	%	%	%	%	%
1	4.66	2.5	6.15	10.06	19.64
2	5.59	7.27	9.66	12.6	21.09
3	6.51	7.63	11.28	13.42	21.32
4	6.65	7.73	11.42	14.77	22.36
5	6.94	8.02	11.81	15.35	23.63
6	7.73	8.17	14.91	15.49	23.73
7	9.89	10.51	16	18.07	24.75
Total	47.96	51.84	81.23	99.75	156.51
Rng	5.23	8.01	9.85	8.01	5.11
Avrg	6.85	7.41	11.6	14.25	22.36
Stdev	1.66	2.41	3.27	2.54	1.79
Sample polys merged	29.12	33.91	47.33	52.75	47.35
Two years merge		49.44		65.35	

Beef Cattle Sciences

Oregon Beef Council Report

Progress Reports – Rangeland Ecology and Management[2]

Conflict stressors, spatial behavior and grazing budgets of cattle

Contact Person: Douglas E. Johnson – OSU Department of Rangeland Ecology and Management
Address: 302B Strand Agriculture Hall, Oregon State University, Corvallis, OR 97331
Phone Number: (541) 737-1624
Email: douglas.e.johnson@oregonstate.edu

Project Objectives: The objective of this study is to develop equipment and software that can monitor stress in beef cattle as reflected in heart rate, body core temperature, and movement patterns and to evaluate the relative effect of common stressors such as noise and activity during gathering and handling.

Project Start Date*:* January 2011
Expected Project Completion Date:

Project Status: 1) Our existing GPS collars were showing quite a bit of wear, especially the cabling to antennas and power lines from battery packs, so we decided to build new units. Because the GPS boards used in the original design were no longer available, we redesigned the GPS collars using GPS boards that log continuously (1 second intervals) but do not write each point to an SD card. This was done so we could extend the logging duration and reduce the number of times animals had to be gathered and handled. The new units were tested at static locations and could log for 19 days and collect over a million positional locations when powered by "D" cell batteries. We constructed 30 collars using a new collar design that places the GPS antenna inside the box with the batteries. This allows neck straps to be adjusted in the field and easy conversion from one type of animal to another. This means that units could be used on sheep, horses, goats, or livestock guarding dogs. Since these units do not write to an SD card, a potential drawback is that the GPS log information is held in volatile memory until the unit is turned off and the information written in a retrievable format. If the unit receives a physical shock or the electrical supply is interrupted, the information can be lost. We tested these units on sheep in small pastures and found that the units performed well; however, sheep in small pastures are easier on collars than are free-roaming cattle. We performed a second test on heifers in small pastures and again found that the collars performed well. We just completed a third field test to evaluate units and determine their reliability with free-roaming cattle. Only two units of 16 were able to log data. We are bench testing new PCB boards that write to a micro SD card and will fit in the existing collars to ensure accuracy and compatibility with project goals. The SD card will preserve data even if power to the unit is lost. This will, of course, reduce the length of time that collars can be deployed. Duration of logging with the new boards is currently being determined.
2) A second printed circuit board design was purchased (20 units) that writes to an SD card and can be programmed to accept input from external sensors. We have worked with two digital types of sensors. The first is a thermistor attached to a wire that records temperature at a chosen interval. The second is an infrared thermometer that functions similarly to the thermistor. This electronic setup will allow us to log date and time stamped positions and temperature as determined from either an infrared thermometer that can be placed in the cow's ear or a thermistor against the skin. The temperature obtained from the ear should be the more reliable index of body core temperature.

1. This document is part of the Oregon State University – 2011 Oregon Beef Council Report. Please visit the Beef Cattle Sciences website at http://beefcattle.ans.oregonstate.edu.

3) We re-programmed firmware on the Clark ATS to improve accuracy and flexibility of the units. This firmware was bench tested and appears to substantially improve the quality of collected data. Field testing is proceeding at this time.
4) Last spring we tested heart rate monitors on cattle and found that current designs do not reliably monitor heart rate. We are continuing to work on this issue, but at this time we cannot monitor heart rate on free roaming animals.
5) Several stand-alone recording thermal sensors were purchased by the project and are available for use with mature cows.
6) Several software programs were created to facilitate the processing of collected data.
7) Trials with cattle will be conducted this fall as animals become available.

Potential Benefits of Sagebrush Consumption by Cattle

Contact Person: Jose Alberto Perez-Amaro and Ricardo Mata-Gonzalez – OSU Department of Rangeland Ecology and Management
Address: 205B Strand Agriculture Hall, Oregon State University, Corvallis, OR 97331
Phone Number: (541) 737-7355
Email: amaroj@onid.orst.edu and ricardo.matagonzalez@oregonstate.edu

Project Objectives: To determine if small amounts of dietary sagebrush would have beneficial effects on cattle.

Project Start Date*:* June 2011
Expected Project Completion Date: June 2012

Project Status: Previous research has shown that sagebrush produces plant secondary metabolites such as terpenes which serve the purpose of deterring its consumption by herbivores. Many herbivores limit the intake of otherwise nutritious plants such as sagebrush because of the toxicity posed by plant secondary metabolites. However, it has also been established that plant secondary metabolites in small amounts can promote good animal health due to their anti-parasitic, anti-bacterial, and anti-fungal properties. Therefore, it is possible that at appropriate doses plant secondary metabolites can be more beneficial than detrimental for animal health. A controlled feeding trial was conducted to explore the potential benefits of limited sagebrush consumption in cattle. Sagebrush was mixed with hay in the diets of five fistulated steers at rates of 0%, 0.5%, 1%, 3% and 9%. Every steer had each diet for periods of 21 days. Live weights and hay consumption were periodically recorded and fecal material was obtained for posterior laboratory analysis. Live weights increased in a curvilinear fashion as the proportion of sagebrush increased. A maximum proportion of sagebrush in the diet with positive effects in weight gain might be 5%. However, sagebrush consumption of 9% or more would have negative weight consequences. These preliminary results will be complemented with further analyses to better elucidate the potential benefits of sagebrush consumption by cattle.

REPORT STATUS OF STUDIES FUNDED BY THE OREGON BEEF COUNCIL

Progress report not required for studies funded prior to 2009-2010 FY and with a full report submitted.

Projects funded in 2007 – 2008 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Full
Rangeland Ecology and Management			
Wolf impact on cattle productivity and behavior	D.E. Johnson		**X**
Development of digital charting system for range health	D.E. Johnson		**X**
Livestock, plant community, and sage-grouse food sources	J. Miller		**X**
Animal Sciences			
Digestibility of cool-season in dairy farms	T. Downing		**X**
Female hormones and immune cells in cattle	M. Cannon		**X**
Diagnostic test for pregnancy detection in cattle	F. Menino		**X**
Assay to assess bovine embryo viability during transfer	F. Menino		**X**
Farm-based livestock manure/biogas production	M. Gamroth		**X**
Glycerol supplementation to cattle	C. Mueller	**X**	
Copper and Zinc in dairy forage systems	T. Downing		**X**

Projects funded in 2008 – 2009 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Full
Rangeland Ecology and Management			
Wolf impact on cattle productivity and behavior (cont.)	D.E. Johnson		**X**
Rangeland vegetation and sediment monitoring	L. Larson	**X**	**X**
Animal Sciences			
Late gestation protein supplementation of beef cows	D. Bohnert		**X**
Grazing options with *Brassicas* and Fodder Radishes	C. Engel		**X**
Maternal marbling potential and ultrasound technology	C. Mueller		**X**
Replacement heifers sired by high or low-marbling bulls	C. Mueller	**X**	**X**
BVDV and BVDV PI screening to initiate BVDB control	B. Riggs		**X**
Selenium supplementation and retention in beef cattle	G. Pirelli	**X**	**X**
Farm-based livestock manure/biogas production (cont.)	M. Gamroth		**X**

Projects funded in 2009 – 2010 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Full
Rangeland Ecology and Management			
Wolf impact on cattle productivity and behavior (cont.)	D.E. Johnson		**X**
DNA analysis for cattle diet in sagebrush rangelands	R. Mata-Gonzales	**X**	**X**
Behavior and distribution of cattle grazing riparian zones	D.E. Johnson		**X**
Animal Sciences			
PFG2α to improve uterine health and reproductive efficiency	M. Cannon		**X**
Disposition and reproductive performance of brood cows	R. Cooke	**X**	**X**
Acclimation to handling and heifer development	R. Cooke	**X**	**X**
Farm-based livestock manure/biogas production (cont.)	M. Gamroth		**X**

Projects funded in 2010 – 2011 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Full
Rangeland Ecology and Management			
Conflict stressors, spatial behavior and grazing budgets of cattle	D.E. Johnson	**X**	
Behavior and distribution of cattle grazing riparian zones **(cont.)**	D.E. Johnson		**X**
Grazing and medusahead invasion in sagebrush steppe	D. Johnson	**X**	**X**
Weeds to suppress cheatgrass and medusahead	P. Dysart	**X**	**X**
Effects of wolves on cattle production systems **(cont.)**	D.E. Johnson		**X**
Quantities diet analysis in cattle using fecal DNA	R. Mata-Gonzales	**X**	**X**
Animal Sciences			
Protein Supplementation to Low-Quality Forage	D. Bohnert	**X**	**X**
Disposition, acclimation, and steer feedlot performance	R. Cooke	**X**	**X**
Nutrition during bull development on calf performance	C. Mueller	**X**	**X**
Changes in milk parameters in dairy cows with metabolic disorders	A. Villarroel	**X**	
Extending grazing season with warm season and Brassica forages	S. Filley	**X**	**X**
Oral Selenium drench at birth to calves	J. Hall		

Projects funded in 2011 – 2012 FY

Abbreviated Project Title	Senior Investigator	Report Status Progress	Full
Rangeland Ecology and Management			
Revegetating sagebrush rangelands Invaded by Medusahead	D. Johnson	**X**	**X**
Potential benefits of Sagebrush consumption by cattle	R. Mata-Gonzales	**X**	
Effect of wolves on cattle production systems (cont.)	D.E. Johnson		
Evaluation of conflict stressors on spatial behavior and grazing budgets of cattle (cont.)	D.E. Johnson	**X**	
Animal Sciences			
Effects of camelina meal supplementation to beef cattle	R. Cooke	**X**	**X**
The economics of grassed-based dairying in Oregon	T. Downing	**X**	
Yeast culture supp. improves feed consumption in cattle	G. Bobe	**X**	
Western Juniper - Induced Abortions in Beef Cattle	C. Parsons	**X**	
A pilot study to evaluate in the association of metabolic disorders in early lactation and the incidence of anoestrus in dairy cows	A. Villarroel	**X**	

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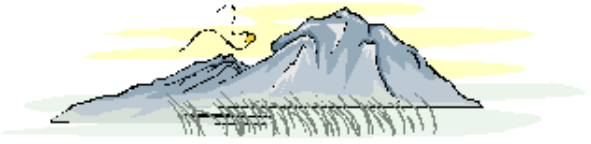
Beef Cattle Sciences



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A Vision for Rangeland and Pasture Research

We acknowledge Mrs. Flavia Cooke (Faculty Research Assistant – OSU, EOARC Burns) for replicating and assembling all reports.