The Effects of Diet on the Biochemical Constituents of Beef

Kimberly A. Varnold
Chris R. Calkins
Brandon L. Nuttelman
Lasika S. Senaratne-Lenagala
Justine J. Stevenson
Michelle E. Semler
Michael D. Chao
Tommi F. Jones
Galen E. Erickson[1]

Summary

Crossbred steers (n = 64) were grazed on warm- or cool-season grasses, without or with energy supplementation of wet distillers grains with solubles (WDGS), and were finished on a corn-based diet with or without 35% WDGS. Grass-type was the major contributor in determining the biochemical composition of L. dorsi steaks, with warm-season grasses causing increased concentrations of moisture and zinc and decreased concentrations of magnesium. Aging 28 days instead of 7 days increased pH and caused an increased concentration of carbohydrates, and non-heme and heme iron in B. femoris steaks. Diet, especially grass type, during grazing, can alter the end composition of beef.

Introduction

The diet of beef cattle can influence many of the biochemical constituents in meat. Research has shown that grass type grazed post-weaning can alter the composition of beef (*Journal of Food Science,* 1987, 52:245-251). It is also very common to supplement energy while grazing by feeding wet distillers grains plus solubles (WDGS). Providing supplementation alters growth traits (*2013 Nebraska Beef Cattle Report*, pp. 31-32 and *2011 Nebraska Beef Cattle Report*, pp. 24-25) and the biochemical composition of the beef (*Food Chemistry,* 1998, 63:543-547). Finishing cattle on WDGS also causes changes in the biochemical composition of beef (*2011 Nebraska Beef Cattle Report*, pp. 96-99). Biochemical changes in the meat could lead to changes in flavor and consumer acceptability. The objective of this study was to identify changes in beef composition in two different muscles from cattle fed two different forages post-weaning, with or without supplemental energy, finished on either a corn or WDGS diet, and aged for 7 or 28 days.

Procedure

Crossbred steers (n = 64) were allowed to graze for from April 17, 2012, until Oct. 10, 2012, (177 days) on warm-season grasses at the Barta Brothers Ranch in the Eastern Sandhills of Nebraska or on cool-season pastures near Ithaca, Neb., without or with energy supplementation of wet distillers grains with solubles WDGS (0.6% BW/ day). After the grazing period, cattle were finished on a corn based diet with or without 35% WDGS for 119 days to an average live weight of 1,427 lbs. Cattle were harvested at the Greater Omaha Packing Co. in Omaha, Neb.

Six carcasses from each treatment (n = 48) that graded USDA Choice or Select were identified and *Longissimus dorsi (L. dorsi)* and *Biceps femoris* (*B. femoris*) muscles from each side of each carcass were collected and aged under vacuum for 7 and 28 days. After aging, one steak was cut from each muscle and analyzed for proximate composition, pH, cooking loss, and heme and non-heme iron content, amino acid composition, and mineral content.

Ultimate pH was determined for 7 and 28 day aged samples using an Orion 4 STAR pH ISE Bench-top meter (Thermo Electron Corporation, Waltham, Mass.). Fat, protein, and ash content were analyzed for seven-day aged samples while moisture content was analyzed for both 7- and 28-day samples. Moisture and ash were measured using a LECO thermogravimetric analyzer and fat was measured using an ether extraction procedure. Protein was determined by difference (100% - % fat, % moisture and % ash).

For total carbohydrates, samples were extracted using an 80% ethanol solution. The extract was then mixed with 80% phenol and sulfuric acid and the optical density was read on a Cary 100 Varian UV/Visual Spectrophotometer (Varian Instruments, Sugarland, Tex.) at 490 nm. All results were compared to a standard curve for total concentration.

To measure non-heme iron, samples were mixed with a $NaNO_2$ solution (0.39% w/v) and 40% (1:1) trichloroacetic acid:hydrochloric acid acid solution, vortexed, and placed in a water shaker bath set at 149°F for 20 hours. A 1 mL aliquot of the aqueous phase was mixed with a color reagent and read on a spectrophotometer, against a blank, at 540 nm. Readings were compared against a standard curve created using an iron stock standard. Similarly, heme iron samples were mixed with acetone and hydrochloric acid, homogenized, filtered into a new tube, and read on a spectrophotometer at 640 nm.

Mineral composition of seven-day samples was determined with an atomic absorption spectrophotometer (Ward Laboratories, Inc. in Kearney, Neb). Amino acid composition of seven-day samples was determined by AAA Service Laboratory, Inc. in Damascus, Ore. Samples were weighed, dried, and hydrolyzed in HCl/2% phenol at 230°F for 22 hours. Next, the hydrolysate was dried and a sample was injected onto a Hitachi L8900 Amino Acid Analyzer with post-column-ninhydrin derivatization. Norleucine was added to the samples to act as an internal control.

Table 1. The effect of grass type, supplementation, and aging period on the LS means scores of select characteristics of *L. dorsi* and *B. femoris* steaks.

	Grass Type				Supplementation				Age			
	Warm-Season	Cool-Season	SEM	*P*-value	No	Yes	SEM	*P*-Value	7 Days	28 Days	SEM	*P*-value
L. dorsi												
pH	5.46	5.39	0.03	0.06	5.45	5.40	0.03	0.24	5.28[b]	5.57[a]	0.03	<0.0001
Moisture, %	71.62[a]	70.67[b]	0.23	0.04	71.34	70.95	0.23	0.38	71.14[a]	70.39[b]	0.23	0.02
Protein, %	20.91	21.07	0.15	0.46	21.24[a]	20.75[b]	0.15	0.03	NA[1]	NA	NA	NA
Magnesium, mg/kg	291.67[b]	326.67[a]	11.37	0.03	300.00	318.33	11.37	0.26	NA	NA	NA	NA
Zinc, mg/kg	42.29[a]	37.46[b]	1.01	0.002	39.00	40.75	1.01	0.22	NA	NA	NA	NA
Sulfur, mg/kg	2012.50	2060.00	17.52	0.06	2041.67	2030.83	17.52	0.66	NA	NA	NA	NA
B. femoris												
pH	5.52	5.52	0.03	0.99	5.53	5.52	0.03	0.69	5.39[b]	5.65[a]	0.03	<0.0001
Moisture, %	71.90	71.66	0.19	0.46	71.87	71.69	0.19	0.58	71.78	71.29	0.19	0.08
Total Carbohydrates, mg/mL	0.91	0.91	0.04	0.99	0.91	0.90	0.04	0.84	0.81[b]	1.00[a]	0.04	0.0003
Non-Heme Iron, µg/g meat	2.81	2.50	0.20	0.28	2.62	2.70	0.20	0.77	2.29[b]	3.02[a]	0.20	0.01
Heme Iron, mg/kg	10.09	10.03	0.19	0.83	10.00	10.11	0.19	0.68	9.54[b]	10.58[a]	0.19	0.0001

[1]NA = Not applicable, aging period was not tested for these factors.
[ab]Means within the same treatment and the same row with different superscripts are different ($P \leq 0.05$).

Data were analyzed using the Mixed procedure in SAS (SAS Institute, Inc., Cary, N.C.) with differences determined at $P \leq 0.05$. Whenever there was a three- or four-way interaction, the LSmeans were reanalyzed using the GLIMMIX procedure with the slicediff option in order to more accurately study differences.

Results

For both *L. dorsi* and *B. femoris* steaks, aging 28 days increased pH values ($P < 0.0001$) as compared to seven day aged beef (Table 1). A change in pH will have an effect on flavor as well as shelf life. Warm-season grass increased ($P = 0.04$) moisture content, decreased magnesium, and increased zinc concentration in *L. dorsi* steaks ($P \leq 0.03$) as compared to cool-season grasses (Table 1). In addition, grazing on a warm-season grass had the tendency ($P = 0.06$) to decrease sulfur content. Beef from cattle grazing warm-season grasses tended to have higher zinc and lower sulfur concentrations than beef from cattle grazing cool-season grasses.

Also, in *L. dorsi* steaks, supplementation decreased ($P = 0.03$) protein content (Table 1). There was a three-way interaction between grass type, supplementation, and finishing diet ($P = 0.04$) for ash content (Figure 1). Within warm-season grass grazing, not supplementing and finishing on WDGS caused ash content to be the
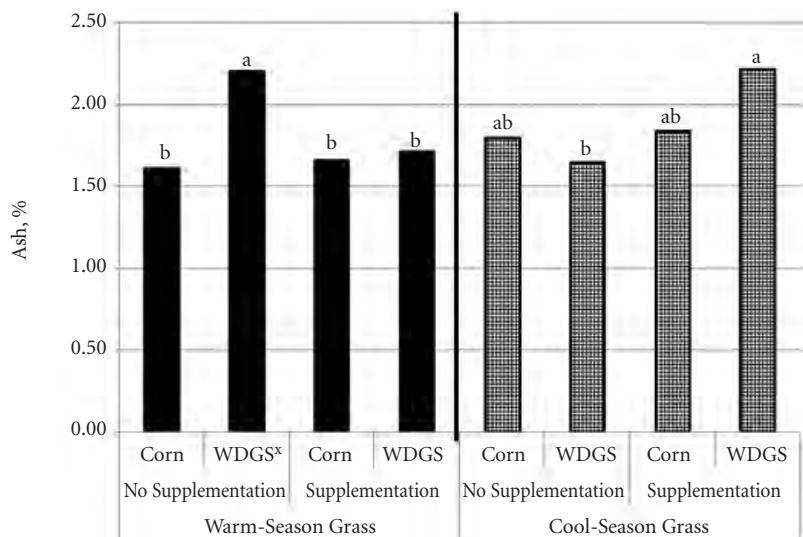
[x]WDGS = Wet distillers grains with solubles.
[ab]Means within the same grass type with the different superscripts are significantly ($P \leq 0.05$) different.
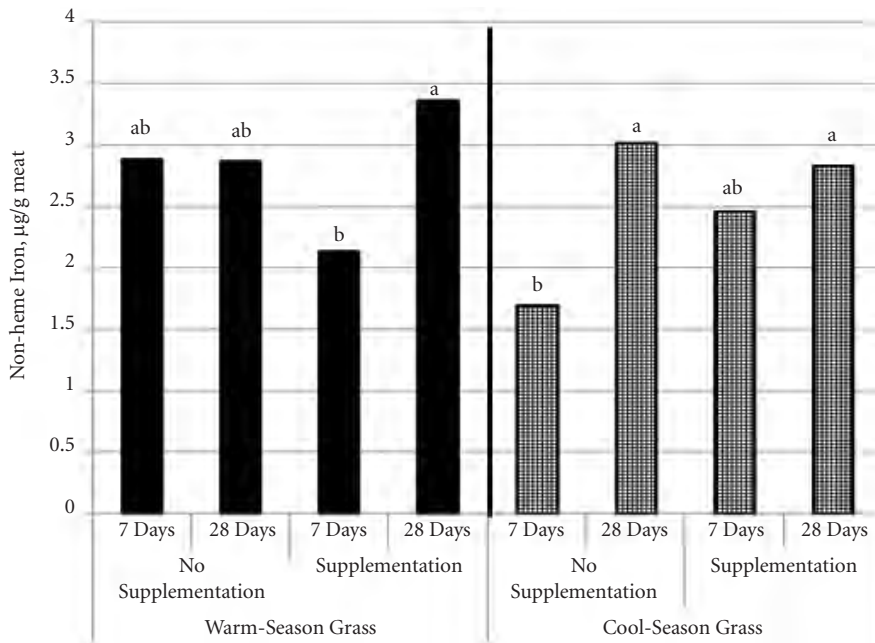
Figure 1. The interaction between grass type, supplementation, and finishing diet on the LS means of ash content when separated by grass type for *L. dorsi* steaks ($P = 0.04$).
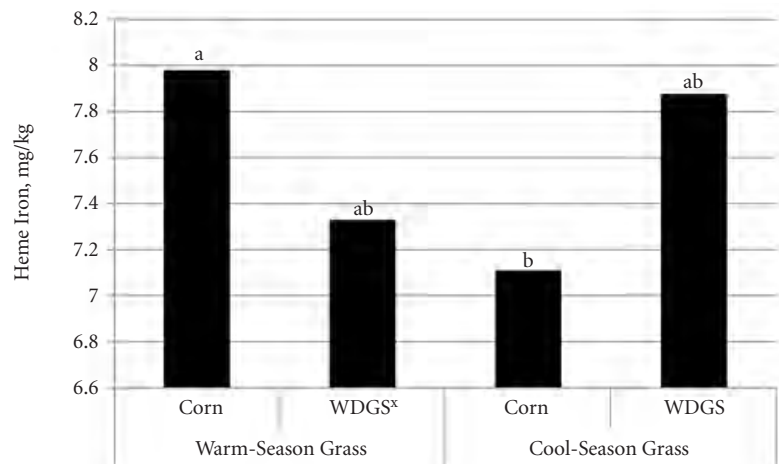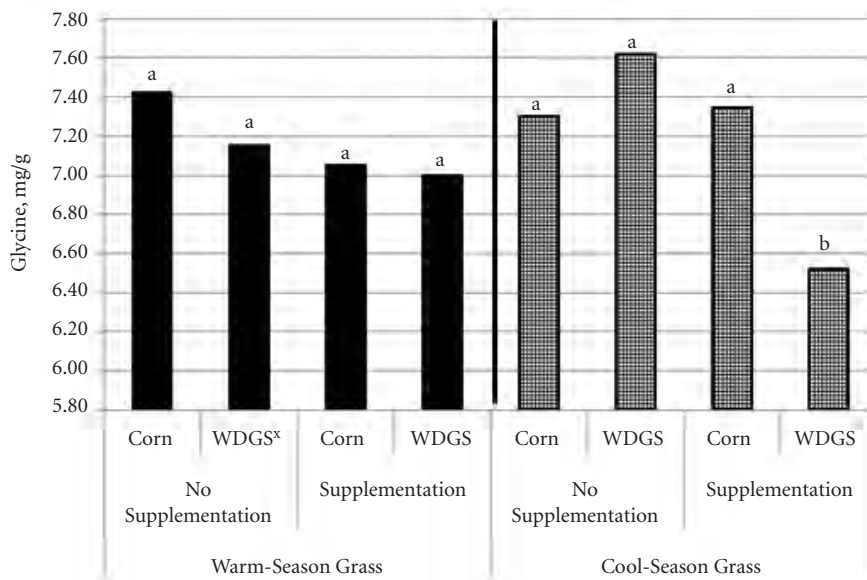

[x]WDGS = Wet distillers grains with solubles.
[ab]Means within the same grass type with the different superscripts are significantly ($P \leq 0.05$) different.

Figure 2. The interaction between grass type and finishing diet on the LS means of heme iron content for *L. dorsi* steaks ($P = 0.003$).

abMeans within the same grass type with the different superscripts are significantly ($P \leq 0.05$) different.

Figure 3. The interaction between grass type, supplementation, and aging period on LS means of non-heme iron content when separated by grass type for *B. femoris* steaks ($P = 0.05$).

xWDGS = Wet distillers grains with solubles.
abMeans within the same grass type with the different superscripts are significantly ($P \leq 0.05$) different.

Figure 4. The interaction between grass type, supplementation, and finishing diet on the LS means of glycine content when separated by grass type for *B. femoris* steaks ($P = 0.05$).

highest (2.20%) compared to any other supplementation and finishing diet combination ($P = 0.04$). Within cool-season grass grazing, supplementing and finishing on WDGS caused the ash content to be higher than if they weren't supplemented and finished on WDGS. Beef from corn-finished cattle had a higher heme iron content ($P = 0.003$) when grazed on warm-season versus cool-season grasses in *L. dorsi* steaks (Figure 2). The location of the ranches and the changes in both soil type and geography could have played a role in the differences seen with heme iron content.

Carbohydrates increased ($P = 0.0003$) in *B. femoris* steaks when aged 28 days as compared to seven days. As meat ages, moisture content decreases, as can be seen in Table 1 for the *L. dorsi* steaks ($P = 0.02$) with a similar tendency in the *B. femoris* steaks ($P = 0.08$). When the moisture content decreases due to aging, other components, such as carbohydrates, become more concentrated.

A three-way interaction ($P = 0.05$) between grass type, supplementation, and aging period influenced non-heme iron content in *B. femoris* steaks. Within warm-season grass grazing, when the animals were supplemented, 28-day aged product had a higher non-heme iron concentration ($P = 0.05$) than seven-day aged beef (Figure 3). Within cool-season grass grazing, 28 day-aged beef, from both not supplemented and supplemented cattle, had higher non-heme iron concentrations than seven-day aged beef from cattle that were not supplemented. Aging steaks 28 days caused the concentration of heme iron to be significantly ($P = 0.0001$) higher than seven-day aged steaks (Table 1), likely due to water being exuded from the meat and other components become more concentrated.

Glycine content was influenced ($P = 0.05$) by grass type, supplementation, and finishing diet interaction in *B. femoris* steaks (Figure 4). Within

warm-season grass grazing there were no differences ($P > 0.05$) among dietary treatments. When cattle were grazed on cool-season grasses, providing supplementation and finishing on a WDGS diet caused the lowest glycine concentration compared to all other supplementation and finishing diet combinations. When finished on WDGS, *B. femoris* steaks from cattle that were not supplemented had higher phosphorus levels than when they were supplemented (Figure 5). The remaining components were unaffected by diet and aging period.

Overall, grass type and aging were found to have the most effect on the biochemical constituents of meat. This shows that the grass type cattle grazed after weaning can still cause a residual effect on the meat composition even after finishing on a high concentrate diet. In most cases, the addition of supplementation to the dietary regimen was able to even out the effects and remove any differences due to grass type.
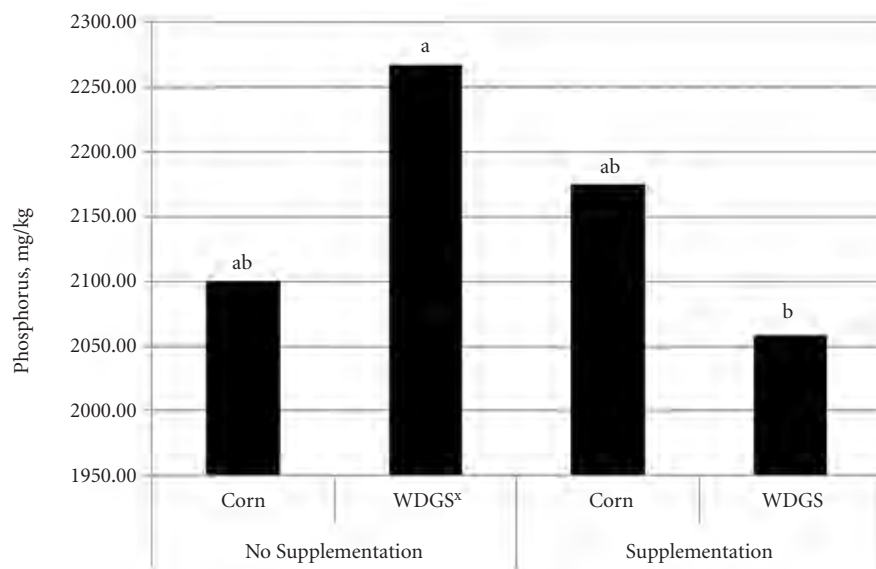
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[1]Kimberly A. Varnold, graduate student; Chris R. Calkins, professor; Brandon L. Nuttelman, graduate student; Lasika S. Senaratne, former graduate student; Justine J. Stevenson, former graduate student; Michelle E. Semler, graduate student; Michael D. Chao, graduate student; Tommi F. Jones, laboratory technician; Galen E. Erickson, professor, University of Nebraska–Lincoln Department of Animal Science, Lincoln, Neb.

[x]WDGS = Wet distillers grains with solubles.
[ab]Means within the same grass type with the different superscripts are significantly ($P \leq 0.05$) different.

Figure 5. **The effect of supplementation and finishing diet on the LS means of phosphorous content in *B. femoris* steaks ($P = 0.04$).**