Effects of distillers dried grains with solubles supplementation on yearling heifers grazing Northern Great Plains rangeland: impacts on subsequent feedlot performance and meat quality[1]

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ABSTRACT: Eighty-two yearling crossbred heifers (318.8 ± 1.03 kg) were utilized in a completely randomized design to evaluate the effects of distillers dried grains with solubles (DDGS) supplementation on animal performance, while grazing on rangeland of the Northern Great Plains, and subsequent feedlot performance, carcass characteristics, and meat quality traits. Treatments were: 1) 0% DDGS supplementation (CONT) and 2) 0.6% of body weight (BW) DDGS supplementation (SUP). Heifers received treatments for 70 d (6 June to 16 August) while grazing, and then were acclimated to and fed a common corn-based finishing diet for 109 d. Average daily gain (ADG) of SUP heifers was greater ($P \leq 0.01$), resulting in heavier BW ($P \leq 0.03$) following grazing compared with CONT heifers. Heifer performance, including ADG (1.91 ± 0.05 kg/d), gain to feed (G:F) (0.15 ± 0.003 kg), dry matter intake (DMI) (12.6 ± 0.20 kg), and final BW (572.4 ± 7.43 kg) were not different ($P \geq 0.13$) during finishing. Hot carcass weight (335.7 ± 4.39 kg), *Longissimus* muscle area (81.30 ± 1.24 cm^2), 12th rib fat thickness (1.24 ± 0.06 cm), and kidney, pelvic, heart fat (KPH) (1.85 ± 0.08%) were not different ($P \geq 0.47$) between treatments. There were no differences ($P \geq 0.24$) between treatments in yield grade (2.9 ± 0.10) or marbling (492 ± 22.3; $Small^{00}$ = 400). Results from Warner–Bratzler shear force indicated that strip loin steaks from SUP heifers tended ($P = 0.07$) to have increased tenderness compared with strip loin steaks from CONT heifers (3.3 vs. 3.7 ± 0.12 kg, respectively). Inclusion of 0.6% BW supplementation during grazing increased ($P = 0.01$) strip loin steak muscle lightness (L*) compared with CONT steaks (46.5 vs. 45.5 ± 0.27, respectively). Strip loin steaks from heifers supplemented DDGS during grazing were perceived to be more tender by taste panelists ($P = 0.02$) than strip loin steaks from CONT heifers (5.9 vs. 5.5 ± 0.11; eight-point scale). Supplementation of DDGS during grazing improved ADG of yearling heifers with no effect on feedlot performance or carcass characteristics but did improve tenderness and steak sensory attributes.

Key Words: carcass characteristics, distillers dried grains with solubles, feedlot performance, grazing performance, meat quality

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INTRODUCTION

Supplementation during grazing becomes an important management strategy when forage quality and quantity are typically lowest. In the Northern Great Plains, this occurs during the

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summer period when cool-season grasses are maturing and prior to fall regrowth of lush plant material (Caton and Dhuyvetter, 1997). Distillers dried grains with solubles (DDGS) are a coproduct of ethanol production with concentrations of protein, fat, fiber, and phosphorus three times greater than those of corn (Klopfenstein et al., 2008); therefore, DDGS has been extensively researched as a supplemental form of energy and protein. DDGS can offset the nutritional deficiencies in the animal and improve performance while grazing (Morris et al., 2006; MacDonald et al., 2007).

Inclusion of DDGS in finishing diets has been shown to decrease muscle redness (a*) values during retail shelf life (Gill et al., 2008; Depenbusch et al., 2009). Zerby et al. (1999) correlated greater a* values to increased consumer acceptance of the product. DDGS increases the formation of polyunsaturated fatty acids (PUFA) in meat, leading to a faster oxidation during retail shelf life (Gill et al., 2008; Leupp et al., 2009), which may deter consumer's purchase. Research is needed to evaluate DDGS supplementation during grazing and the comprehensive impacts DDGS has on animal performance and meat quality throughout the beef supply chain. Therefore, our objective was to evaluate the effects of supplemental DDGS provided to heifers during grazing on animal performance during both grazing and subsequent feedlot production, as well as carcass characteristics, steak color, and sensory attributes. Our hypothesis was that supplementation of DDGS to grazing heifers would increase average daily gain (ADG) without affecting finishing performance, carcass characteristics, or meat quality.

MATERIALS AND METHODS

All animal care and handling procedures followed protocols approved by the North Dakota State University Animal Care and Use Committee prior to initiation of study. Procedures using human subjects for sensory panel were approved by the North Dakota State University Institutional Review Board before initiation of the panel.

Grazing Study

This study was conducted at Central Grasslands Research and Extension Center (CGREC) located in south-central North Dakota, approximately 14 km northwest of Streeter, North Dakota. This region of North Dakota is near the eastern edge of the Missouri Coteau, an area of young morainic hills formed from recent glaciation (Lura, 1985; Schauer et al., 2004). The south-central region of North Dakota experiences approximately 120 frost-free days per year. Temperatures range from an average high monthly temperature of 27 °C in July to an average low monthly temperature of −17 °C in January (North Dakota Agricultural Weather Network, 2014). Average annual rainfall of 39.68 cm is seasonal with over 74% occurring from May through September (29.35 cm; North Dakota Agricultural Weather Network, 2014).

Kentucky bluegrass (*Poa pratensis*) is the most prevalent species on the study site (Neville and Patton, unpublished data). Other important forage species in the area include blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sun sedge (*Carex inops*), and western snowberry (*Symphoricarpos occidentalis*) (Hirschfeld et al., 1996).

Eighty-two crossbred heifers (318.8 ± 1.03 kg) were utilized in a completely randomized design. Heifers were stratified by body weight (BW) and then assigned randomly to one of six groups for a 70 d grazing study starting on 6 June. Groups were assigned randomly to one of two treatments: 1) 0% DDGS supplementation (CONT) or 2) 0.6% of BW DDGS supplementation (SUP). Pasture served as the experimental unit (*n* = 3 pastures per treatment). Stocking density was 1.0 animal unit/1.6 ha (animal unit = 453.5 kg live animal weight). Heifers were allowed continuous access to water, trace-mineralized salt blocks (American Stockman Hi-Salt with EDDI; North American Salt Company, Overland Park, KS), and mineral blocks (Purina Mineral Block 12:12 HI-SE; Purina Mills, LLC, St. Louis, MO). Supplemental DDGS were hand-delivered to feeders in treatment pastures at 0800 h, 5 d/week.

Refused feed was removed and weighed before each feeding at 0800 h. Initial and final BW were the average of two BW taken on consecutive days. Intermediate BW were taken every 14 d on all animals to monitor weight and to keep supplementation consistent with increasing body weights. Sample forage clippings were taken from pastures at the beginning of the experiment and continuing every 28 d until the end of the grazing study for a total of three sample times. At each sampling date, five 0.25 m^2 plots were selected at random for clipping per pasture or 15 total plots per treatment.

Finishing Study

Grazing was terminated on 16 August. Heifers were transported to the CGREC headquarters to begin the 109 d finishing period. Each feedlot pen coincided to a grazing pasture with heifers maintained in the same groups as during grazing. Heifers were started on a medium concentrate diet (DM basis: 40% corn silage, 29.9% dry rolled corn, 19.9% sainfoin [*Onobrychis viciifolia* Scop.] hay, 5% barley, 5% liquid supplement, and 0.2% limestone) and were transitioned to a high concentrate diet over 28 d with the use of five diets each with successively greater concentration of grain and less roughage. All heifers received the same corn-based finishing ration (DM basis: 54.8% dry rolled corn, 25% barley, 10% sainfoin hay, 5% corn silage, 5% liquid supplement [Sup-R-Lix NC Feedlot 40 R400; Purina Mills, LLC, St. Louis, MO], and 0.2% limestone). Finishing ration was formulated to meet or exceed dietary National Research Council requirements. Liquid supplement (DM basis) included 400 g/T monensin, 40% CP, 3% crude fat, 5.5% calcium, 0.3% phosphorus, 2.5% salt, 1.5% potassium, and 88,200 IU/kg vitamin A. Refused feed was removed and weighed weekly prior to feeding at 0800 h. Heifers were implanted with Synovex Choice (Zoetis, Florham Park, NJ) on day 1 in feedlot. Initial and final BW was the average of 2 BW taken on consecutive days, with intermediate BW taken every 28 d. All heifers were harvested on a single day, which was selected based on a combination of body weight and visual appraisal. Heifers were transported 660 km and humanely harvested at a commercial, federally inspected abattoir (Tyson Fresh Meats Inc., Dakota City, NE).

Diet Analysis

Sample forage clippings were dried using a forced air oven (65 °C; The Grieve Corporation, Round Lake, IL) for a minimum of 72 h. Dried samples were ground using a Wiley Mill (Arthur H. Thomas Co., Philadelphia, PA) to pass a 2 mm screen. Forage samples were analyzed for DM, ash, crude protein (CP), phosphorus, calcium (methods 934.01, 942.05, 2001.11, 965.17, and 968.08, respectively; AOAC, 2010), in vitro dry matter digestibility, and in vitro organic matter digestibility (IVOMD) (Tilley and Terry, 1963). Concentrations of neutral detergent fiber (NDF) (Van Soest et al., 1991; as modified by Ankom Technology, Fairport, NY) and acid detergent fiber (ADF) (Goering and Van Soest, 1970, as modified by Ankom Technology) were determined using an Ankom 200 Fiber Analyzer (Ankom Technology, Macedon, NY).

Feed refusals from grazing and finishing periods were collected and dried using a forced air oven (65 °C; The Grieve Corporation, Round Lake, IL) for a minimum of 48 h for determination of DM content. Dry matter feed refusals were used to calculate DDGS intake during grazing and DMI during finishing.

Carcass Sample Collection

Hot carcass weight was measured within 30 min after exsanguination. Following an approximate 24 h chill at −2 °C, personnel with experience in beef carcass evaluation measured *Longissimus* muscle (LM) area and 12th rib fat and visually assessed maturity, marbling score, and kidney, pelvic, heart fat (KPH). Strip loins (Beef Loin, Strip Loin, Boneless; Institutional Meat Purchase Specifications [IMPS] #180) were removed after carcasses were chilled for 24 to 48 h. The loin samples were transported to North Dakota State University for subsequent analysis. Loin samples were in dark storage period for 7 d before being processed into 2.5 cm thick steaks. Steaks were vacuum packaged individually.

Retail Display Life

One steak from each strip loin was used for simulated retail display life analysis. Following the initial 7 d aging, one steak from each loin was prepared immediately for retail display life. For analysis, all steaks were overwrapped with oxygen-permeable polyvinyl chloride film and placed under direct soft white fluorescent bulbs (General Electric, Ecolux, Cleveland, OH) at 2 °C. Steaks were rotated randomly and evaluated every 24 h by personnel previously trained to identify discoloration and determine the percent of the surface that was discolored for percent metmyoglobin discoloration (expressed as percentage discoloration relative to the surface area of the steak) and objective color evaluation throughout 10 d period. Objective color evaluation was conducted using a colorimeter (Chroma Meter CR-310, Minolta Corp., Ramsey, NJ) equipped with a 50 mm aperture utilizing a D65 illuminant. Colorimeter was calibrated to white plate overwrapped with the same polyvinyl chloride film used for retail packaging prior to color evaluation. Color readings measured LM lean L* (muscle lightness), a* (muscle redness), and b* (muscle yellowness) through the overwrap polyvinyl chloride film at 1300 h for each day of postmortem storage.

Tenderness Determination

One steak from each heifer was used for evaluation of tenderness using the Warner–Bratzler shear force (WBSF) machine (G-R Manufacturing, Manhattan, KS; AMSA, 1995). After the initial 7 d dark storage, steaks used for tenderness determination were aged at 4 °C for an additional 7 d. Steaks were weighed and then cooked on clamshell-style grills (model GRP99B, Salton Inc., Lake Forest, IL) at 177 °C until steaks reached an internal temperature of 70 °C. Temperatures were monitored internally in the geometric center of each steak with a copper/constantan, Neoflon perfluoroalkyl-insulated wire and temperatures were recorded using an Omega handheld digital thermometer (model HH801B, Omega Engineering Inc., Stamford, CT). Steaks were then weighed to determine cooking loss and cooled to room temperature. A minimum of six 1.27 cm diameter cores were obtained from each steak parallel to muscle fibers (AMSA, 1995). Each core was sheared once using a 250 mm/min crosshead speed. The mean of the six cores was used in the statistical analysis (AMSA, 1995).

Trained Sensory Panel

Sensory panel analysis was conducted with a trained panel (AMSA, 1995). Following the 7 d dark storage steaks used for sensory panel evaluation were frozen. Prior to evaluation, steaks were thawed at 4 °C for 24 h and cooked as described previously for tenderness determination. Steaks were then cut into pieces of approximately 1.3 × 1.3 × 2.5 cm and served to panelists for evaluation. Panelists were trained to evaluate initial tenderness, juiciness, and flavor intensity (Cross and Dinius, 1978). Panelists scored nine samples each day using an eight-point scale in which 1 equaled extremely tough, dry, and bland and 8 equaled extremely tender, juicy, and intense beef flavor. At least five panelists evaluated samples each day. After each sample, panelists cleansed their palates using distilled water, unsalted crackers, and ricotta cheese.

Statistical Analysis

Forage nutrient data across the growing season was analyzed using the Mixed procedure of SAS (SAS Ins. Inc., Cary, NC) with repeated measures. The model for forage nutrient data included treatment, date, and the interaction of treatment and date. Covariant structure was tested with simple structure being the best fit. All animal data was analyzed using the mixed procedures of SAS. Pasture was used as the experimental unit, and the model for pasture performance, feedlot performance, tenderness determination, and trained sensory panel included the effect of treatment. For trained sensory panel, panelists' evaluations were averaged for the respective sensory attribute as described by AMSA (1995), and then averaged for pasture. The model for the retail display life included treatment, day, and treatment × day interaction. Treatment differences were considered significant at an alpha of $P < 0.05$.

RESULTS AND DISCUSSION

Analyzed composition of DDGS averaged 28.3% CP, 5.4% ash, 29.6% NDF, and 7.0% ADF (DM basis). Heifers assigned to SUP treatment consumed an average of 2.7 kg/d of DDGS (DM basis) over the entire grazing period. Forage nutrient values from June to August are depicted in Table 1. As the grazing period progressed, CP and IVOMD values declined while NDF and ADF values increased, typical of cool-season pastures when forage growth ceases and forage quality starts to decrease (Lardy et al., 2004). Decline in CP content of North Dakota rangelands forage have been reported (Olson et al., 1994; Cline et al., 2009) and follow similar pattern of decline early in the grazing season compared with the present study. Neutral detergent fiber values increased with advancing season similar to other research in North Dakota (Schauer et al., 2004; Cline et al., 2009), while other research has shown NDF concentrations to stay relatively constant during the early grazing season before increasing later in the season (Olson et al.,

Table 1. Nutrient content of native pasture forage in the Northern Great Plains during the grazing season[1]

					P-value		
	June	July	August	SE	Trt[2]	Date	Date × Trt
CP,%	10.2[a]	8.9[b]	8.7[b]	0.31	0.58	0.02	0.56
NDF, %	64.4[a]	66.6[a]	70.5[b]	0.84	0.53	<0.01	0.58
ADF,%	33.8[a]	37.9[b]	39.9[c]	0.51	0.25	<0.01	0.25
Ca, %	0.33	0.38	0.33	0.031	0.97	0.44	0.85
P, %	0.21[a]	0.20[ab]	0.18[b]	0.007	0.08	0.10	0.79
IVOMD, %	64.4[a]	53.3[b]	49.5[c]	0.97	0.10	<0.01	0.41

[1]Based on hand clipped forage samples.

[2]Treatments were: CONT = 0% DDGS supplementation and SUP = 0.6% of BW DDGS supplementation.

[a,b,c]Means within a row with different superscripts differ $P < 0.05$.

1994). Similar to the present study, IVOMD of forage samples decreased with advancing season (Olson et al., 1994; Schauer 2004). Direct comparisons of nutrient values between the current study and previous work is difficult as previous work utilized masticate samples while the current study utilized clipped forages.

Energy and protein are often considered some of the most limited nutrients for grazing livestock (Holechek et al., 1998); therefore, supplementation may help offset these limited nutrients in forage quality and quantity to maintain production demands (Caton and Dhuyvetter, 1997). Determination of when to supplement may be difficult since cattle may select a diet with greater quality than the average value of standing forage (Paterson et al., 1996). In addition, prediction of energy requirements could be underestimated for grazing cattle due to the amount of energy expended for increased maintenance and work associated with grazing (Caton and Dhuyvetter, 1997).

Initial BW was not different between the two treatment groups (P = 0.09) and averaged 318.8 ± 1.03 kg (Table 2). After the grazing period of the study, final BW and ADG during grazing were greater ($P \leq 0.03$) for heifers in the SUP treatment when compared with those in the CONT treatment. Heifers consuming supplemental DDGS gained on average 0.21 kg/d more than nonsupplemented heifers, which equated to an 11.9 kg greater gain on average coming off pasture.

Research has demonstrated that supplementing DDGS during grazing increases ADG and BW (Lomas and Moyer, 2011; Buttrey et al., 2012); however, reasoning behind the increased performance are often contradictory. Supplemental energy and protein provided by the DDGS in the present study may have improved ADG. The relative improvement in ADG observed in the current study was similar to that observed by Martinez-Pérez et al. (2013) in steers supplemented DDGS at 0.6% BW on New Mexico native range. The reasons for differences in animal responses to supplemental DDGS may be due to differences in CP content of forage between studies. When grazing a lesser quality forage (< 7% CP), protein supplementation may negate an metabolizable protein (MP) deficiency by improving forage intake and digestibility (Paterson et al., 1996). However, it is unlikely heifers in the present study were MP deficient. Other factors outside of forage quality could also lead to decreased animal performance; within the context of the current study, animals were treated similarly, reducing the potential for confounding results. Unfortunately, it is difficult to truly determine the impacts of DDGS supplementation on forage intake and digestibility without estimates of intake. The economic feasibility of supplementing DDGS at 0.6% BW would need to be considered by livestock producers prior to implementation and is dependent not only on cost of supplemental feed and improvements in ADG but also potential changes in forage intake and stocking rates of pastures, which were not evaluated in this study.

During the finishing study, all heifers were fed the same diet ad libitum to examine the effects of supplemental DDGS during grazing on subsequent finishing performance and carcass characteristics. Upon entry into feedlot, SUP heifers had greater initial BW (P = 0.03) when compared with CONT heifers (Table 3) due to greater ADG during the grazing period. Performance during finishing and final BW after finishing was similar between SUP and CONT treatments ($P \geq 0.13$; carcass-adjusted performance $P \geq 0.46$). Although finishing performance and final BW between both treatments were statistically

Table 2. Effect of DDGS supplementation on animal performance of heifers grazing Northern Great Plains rangeland during a 70 d grazing study

	Treatment[1]			
Item	CONT	SUP	SEM	P-value
Initial BW, kg	320.3	317.2	1.03	0.09
Final BW, kg	357.6	369.5	2.49	0.03
ADG, kg/d	0.54	0.75	0.021	<0.01

[1] CONT = 0% DDGS supplementation; SUP = 0.6% of BW DDGS supplementation.

Table 3. Effect of DDGS supplementation during grazing on subsequent feedlot performance of heifers fed a common finishing diet during a 109 d finishing study

	Treatment[1]			
Item	CONT	SUP	SEM	P-value
Initial BW, kg	357.6	369.5	2.49	0.03
Final BW, kg	567.7	577.0	7.41	0.42
ADG, kg/d	1.92	1.90	0.048	0.83
DMI, kg	12.9	12.3	0.198	0.13
G:F, kg	0.15	0.15	0.003	0.28
Carcass-adjusted performance				
Final BW[2], kg	570.2	578.5	7.55	0.48
ADG, kg	1.93	1.91	0.05	0.78
G:F, kg	0.15	0.15	0.004	0.46

[1]CONT = 0% DDGS supplementation; SUP = 0.6% of BW DDGS supplementation.

[2]Carcass-adjusted final BW calculated from hot carcass weight (HCW) divided by the average dressing percentage of all treatments.

similar, SUP heifers appear to have maintained the proportional advantage in BW gained during grazing. If supplementation practices are economically feasible, the potential for greater weight may lead to less time spent in feedlot or greater carcass weight when exiting the feedlot. All heifers in the current study were harvested at a common date not allowing for determination of if additional BW gained by supplementation impacted actual days on feed (DOF). Reasonable increases in carcass weight or decreased DOF still play a role in profitability and may affect producer decisions to pursue or not pursue a similar supplementation strategies. Perry et al. (1971) supplemented differing levels of corn (0, one-third of full feed, two-third of full feed, or full feed, where full feed is 6.7 kg/[h·d]) to steers during a 58 d grazing study and found steers fed the highest amount of concentrate during grazing had the least amount of gain during finishing. Perry et al. (1971) estimated that for each additional kilogram gained during grazing, steers gained 0.2 kg less during finishing; however, steers fed full feed during grazing required fewer DOF to reach market weight. While the current research and that of Perry et al. (1971) do not agree on the impacts of supplementation during grazing on finishing performance, some explanation for these differences include differences in gain (1.4 kg/[h·d] vs. 0.75 kg/[h·d]) and supplement source (corn vs. DDGS) between the two studies. Certainly, some management practices have changed in recent years, such as implant strategies, and cattle have also changed from a genetic potential standpoint.

Reuter and Beck (2013) suggest rate-of-gain playing an integral part of carryover effects from stocker cattle moving into finishing. Felix et al. (2011) fed either corn or DDGS (65% DM in diet) to steers during the growing phase to achieve either 0.9 kg/d or 1.4 kg/d predicted BW gain and analyzed subsequent feedlot performance. Regardless of supplement, steers fed at a lesser rate of gain (0.9 kg/d predicted BW) during the growing phase gained 14% faster during finishing, which could be explained by a compensatory response from restricted steers being more efficient during finishing (Felix et al., 2011). In the current study, no difference in ADG was observed between treatments during finishing. However, gains in the current study were less than those reported by Felix et al. (2011) and, thus, could explain the differences observed in finishing performance between the two studies.

Similar to final BW, there were no differences ($P > 0.05$) between treatments (Table 4) in hot carcass weight ($P = 0.47$; 335.7 ± 4.38 kg). *Longissimus* muscle area (81.30 ± 1.24 cm^2), 12th rib fat thickness (1.25 ± 0.06 cm), and KPH (1.85 ± 0.08%) were not different ($P \geq 0.50$) between treatments; therefore, no differences ($P = 0.30$) were observed for yield grade (2.9 ± 0.10).

In the present study, no differences ($P = 0.24$) were observed between treatments for marbling, which averaged 492 ± 22.3 (Small^{00} = 400). There was no treatment × day interaction for L*, a*, and b* ($P \geq 0.99$). Steaks from heifers consuming supplemental DDGS had greater L* ($P = 0.01$) color values when compared with steaks from heifers consuming no supplemental DDGS during grazing (Table 5). No differences were found between treatments for a* ($P = 0.47$) or b* ($P = 0.11$) color values.

In meat, lipid oxidation of unsaturated fatty acids in phospholipids and triacylglycerols accelerates myoglobin oxidation and, therefore, discoloration (Scollan et al., 2006; Faustman et al., 2010). Meat color is vital when making meat-purchasing decisions due to the consumer's association of color as an indicator of freshness during retail display life (Mancini and Hunt, 2005). Color values including a* have been correlated to consumers acceptance of the product (Zerby et al., 1999; Leupp et al., 2009). Several authors are in agreement in that including DDGS during finishing reduces a* color values (Depenbusch et al., 2009; Leupp et al., 2009; Segers et al., 2011). Feeding DDGS has been shown to increase the amount of PUFA in meat (Depenbusch et al., 2009; Segers et al., 2011), leading to a faster oxidation during retail display life, reduced a* color values, and decreased consumer acceptance (Scollan et al., 2006; Segers et al., 2011). The data from the present study indicates that

Table 4. Effect of DDGS supplementation during grazing on subsequent carcass characteristics of heifers following a common finishing diet

	Treatment[1]			
Item	CONT	SUP	SEM	*P*-value
HCW[2], kg	333.2	338.2	4.38	0.47
LM area, cm^2	81.94	80.65	1.235	0.50
12th rib back fat, cm	1.21	1.26	0.057	0.57
Marbling score[3]	470	514	22.3	0.24
KPH, %	1.85	1.85	0.082	0.99
Quality grade[4]	10.2	10.6	0.25	0.28
Yield grade	2.8	3.0	0.10	0.30
Dress, %	58.7	58.3	0.33	0.86

[1]CONT = 0% DDGS supplementation; SUP = 0.6% of BW DDGS supplementation.

[2]HCW = hot carcass weight.

[3]Marbling score based on 400 = Small^{00}.

[4]Quality grade based on Low Choice (Ch$^-$) = 10, High Prime (Pr$^+$) = 15.

Table 5. Effect of DDGS supplementation during grazing on subsequent steak shear force, color analysis, and sensory characteristics of steaks following a common finishing diet

	Treatment[1]			
Item	CONT	SUP	SEM	*P*- value
Steaks, *n*	40	40	—	
Shear force, kg	3.7	3.3	0.12	0.07
Cooking loss[2], %	21.4	18.7	0.62	0.04
Color[3]				
L*	45.5	46.5	0.27	0.01
a*	21.6	21.5	0.11	0.47
b*	9.4	9.3	0.05	0.11
Sensory characteristics[4]				
Tenderness	5.5	5.9	0.11	0.02
Juiciness	5.5	5.6	0.07	0.20
Flavor	5.4	5.4	0.05	0.70

[1]CONT = 0% DDGS supplementation; SUP = 0.6% of BW DDGS supplementation.

[2](Weight loss during cooking/weight before cooking) × 100.

[3]L* = white to black (100 = white, 0 = black); a* = red to green (35 = red, −35 = green); b* = yellow to blue (35 = yellow, −35 = blue).

[4]Tenderness (1 = extremely tough, 8 = extremely tender); juiciness (1 = extremely dry, 8 = extremely juicy); flavor (1 = extremely bland, 8 = extremely flavorful) as measured by a trained sensory panel.

supplementation of DDGS prior to finishing did not affect a* color values. In our study, heifers were not fed any DDGS during finishing, demonstrating that there were not carry over effects of DDGS supplementation on meat color values.

Tenderness is one of the most important factors affecting consumer's perception of palatability (Morgan et al., 1991) with 78% of consumers willing to pay a greater price for the same USDA quality grade if the retailer guarantees the steak's tenderness (Miller et al., 2001). In the present study, WBSF values of steaks from heifers fed supplemental DDGS during grazing tended ($P = 0.07$) to be less than steaks from heifers fed no supplemental DDGS (3.3 vs. 3.7 ± 0.12 kg; respectively; Table 5). In the current study, steaks from both treatment groups would have fit into the threshold of 3.0 to 4.3 and would have satisfied 93% of consumers on tenderness when based on thresholds set by Miller et al. (2001). In addition, cooking loss was less ($P = 0.04$) for SUP compared with CONT treatments (18.7 vs. 21.4 ± 0.62%; respectively). As reported below, there were no differences in juiciness between treatments, indicating that the differences in cooking loss may not have been great enough to cause a change in palatability traits of steaks.

In our study, results from sensory panelists indicated no differences ($P \geq 0.20$) in juiciness or flavor between treatments, which averaged 5.6 ± 0.07 and 5.4 ± 0.05, respectively (eight-point hedonic scale; Table 5). Taste panelists detected that steaks from heifers supplemented DDGS during grazing were more tender ($P = 0.02$) than steaks from nonsupplemented heifers (5.9 vs. 5.5 ± 0.11, respectively). Steaks from SUP heifers may have had increased tenderness due to the slight increase in the amount of marbling in the SUP carcasses, although research has shown little evidence of a strong influence of marbling on tenderness. However, marbling may act as a lubricant during mastication, easing the process of swallowing and improving apparent tenderness (Aberle et al., 2001). The increased tenderness was unexpected given previous research. The underlying mechanism for how supplementing DDGS prior to finishing affected tenderness is unknown.

In conclusion, this research found that supplementation of DDGS to cattle grazing Northern Great Plains rangeland increased average daily gain while grazing with no differences between treatments on finishing performance. Supplementation of DDGS during grazing proved to have no effects on retail display life, more specifically redness of steaks. Supplemental DDGS during grazing increased tenderness of steaks for WBSF and sensory panelists were able to detect the same difference in tenderness. This research demonstrated that supplementing DDGS during grazing to stocker cattle may improve grazing performance with no detrimental impacts on subsequent finishing performance, carcass characteristics, or meat quality attributes. The cost of supplementation practices should be weighed against the potential improvement in animal performance to determine economic feasibility.

Conflict of interest statement. None declared.

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