2012

Effects of feeding field peas in combination with distillers grains plus solubles in finishing and growing diets on cattle performance and carcass characteristics

A. C. Pesta
University of Nebraska-Lincoln

A. H. Titlow
University of Nebraska-Lincoln

J. A. Hansen
Panhandle Research and Extension Center, University of Nebraska, jhansen19@unl.edu

A. L. Berger
Panhandle Research and Extension Center, University of Nebraska, aberger2@unl.edu

S. A. Furman
Panhandle Research and Extension Center, University of Nebraska

See next page for additional authors

Authors
A. C. Pesta, A. H. Titlow, J. A. Hansen, A. L. Berger, S. A. Furman, Matt K. Luebbe, G. E. Erickson, and K. H. Jenkins

The Professional Animal Scientist 28 (2012):534–540

Effects of feeding field peas in combination with distillers grains plus solubles in finishing and growing diets on cattle performance and carcass characteristics[1]

A. C. Pesta,* A. H. Titlow,* J. A. Hansen,† A. L. Berger,† S. A. Furman,† M. K. Luebbe,† PAS, G. E. Erickson,* PAS, and K. H. Jenkins,†[2] PAS

*Department of Animal Science, University of Nebraska, Lincoln 68583-0908; and †University of Nebraska, Panhandle Research and Extension Center, Scottsbluff 69361

ABSTRACT

Two studies were conducted to evaluate field peas and wet or dry corn distillers grains with solubles (WDGS and DDGS, respectively) in finishing and growing diets. In Exp. 1, British crossbred steers (n = 352, initial BW 356 ± 27 kg) were used in a randomized block design with factors being 0 or 20% field peas and 0 or 30% WDGS in dry-rolled corn (DRC) based finishing diets (DM basis). There was an interaction ($P < 0.01$) for DMI and G:F. Feeding WDGS increased ADG ($P < 0.01$), whereas peas had no effect on ADG ($P = 0.33$). Including WDGS increased G:F in diets without peas ($P < 0.01$), but had no impact ($P = 0.12$) in diets containing peas. Peas increased G:F ($P = 0.04$) in diets without WDGS, but decreased G:F ($P = 0.03$) with WDGS. Feeding WDGS increased HCW ($P < 0.01$). In Exp. 2, Continental crossbred heifers (yr. 1; n = 108, initial BW 338 ± 14 kg) and British crossbred steers (yr. 2; n = 90, initial BW 321 ± 10 kg) were assigned randomly to 1 of 9 pastures. Treatments were supplementation with loose DDGS meal on the ground (GROUND), in a bunk (BUNK) or a 25% field peas, 75% DDGS cube on the ground (CUBE) at equal CP. Final BW and ADG were less ($P < 0.01$) for GROUND than for CUBE and BUNK, which were similar. These data indicate up to 50% DRC could be replaced by peas and WDGS, and peas are an acceptable binder for DDGS range cubes.

Key words: distillers grain, feedlot, pasture, supplementation, field pea

INTRODUCTION

Field pea production is increasing in the Northern Plains (NASS, 2009). Most of these peas are grown for the high-value human food market. However, the portion of the crop that does not meet quality standards for human consumption can be priced competitively enough to be used as a livestock feed. Additionally, in some regions, where there is not a processing facility for peas for human food consumption, farmers plant these legumes for both the agronomic benefits to fields and to reduce fallow time (Haynes et al., 1993; Walley et al., 2007). There is interest on the benefits of field peas as an alternative feedstuff for livestock in areas where peas are not processed for human consumption. Previous research has focused on increasing inclusion of field peas in corn-based finishing diets in which field pea inclusion has resulted in either no impact (Lardy et al., 2009; Jenkins et al., 2011), or an increase (Flatt and Stanton, 2000) in G:F. To date, no research has evaluated the impact of combining field peas with grain

[1] A contribution of the University of Nebraska Agricultural Research Division, supported in part by funds provided through the Hatch Act and by the Crop Integration and Production Grant.
[2] Corresponding author: kjenkins2@unl.edu

milling co-products in finishing diets, even though the majority of cattle on feed (Vasconcelos and Galyean, 2007) are being fed diets that include distillers grains (Klopfenstein et al., 2008). Additionally, feeding dried distillers grains with solubles (**DDGS**) to grazing cattle has been shown to increase ADG (Jenkins et al., 2009; Buttrey et al., 2012; Griffin et al., 2012). Feeding on the ground is a beneficial range management practice. It allows producers to move cattle around the pasture, preventing overgrazing in one feeding area. However, Musgrave et al. (2012) found substantial waste when DDGS were fed on the ground. The high fiber and fat content of DDGS make it difficult to cube with minimal fines. Thus, the objectives of this study were to determine 1) the effects of feeding field peas as a partial replacement for corn in diets with or without wet distillers grains with solubles (**WDGS**) for finishing cattle, and 2) if field peas would make a good natural binder for DDGS cubes to prevent waste.

MATERIALS AND METHODS

All animal care and management procedures were approved by the University of Nebraska–Lincoln Institutional Animal Care and Use Committee.

Exp. 1

Three hundred fifty-two British crossbred yearling steers (initial BW = 356 ± 27 kg) were used in a randomized block designed finishing trial at the University of Nebraska–Lincoln Panhandle Research and Extension Center Feedlot located near Scottsbluff, Nebraska. Cattle were sourced from several area ranches and fed a 50% alfalfa hay, 25% WDGS, 25% dry-rolled corn (**DRC**) diet (DM basis) until trial initiation. Steers were limit fed at 2.0% of BW for 5 d before trial initiation and then weighed on d 0 and 1, the average of which was used as initial BW. Cattle were blocked by d-0 BW into weight blocks, stratified by BW within weight block, and assigned randomly to pen. Pens were assigned randomly to 1 of 4 treatments (Table 1) with 11 steers per pen and 8 pens per treatment. Light and heavy blocks had 2 replications per treatment, whereas the medium block had 4. All treatments were equally represented within block. Initial processing on d 0 included vaccination with a modified live virus vaccine for the prevention of infectious bovine rhinotracheitis, bovine viral diarrhea types I and II, PI3, and bovine respiratory syncytial virus (Bovi-Shield Gold 5, Pfizer Animal Health, New York, NY) and for the prevention of *Clostridium chauvoei*, *septicum*, *novyi*, *sordellii*, *perfringens* types C & D and *Moraxella bovis* (Vision-7, Merck Animal Health, Summit, NJ), and treatment with a parasiticide (Ivomec pour-on, Merial, Duluth, GA). A 2 × 2 factorial arrangement of treatments was used with one factor being 0 or 20% whole field peas, the other factor being 0 or 30% corn WDGS. All diets were based on DRC and contained 7.5% alfalfa hay and 6.0% liquid supplement, which was formulated to provide 33 mg/kg of monensin (DM basis; Elanco Animal Health, Greenfield, IN) and 90 mg/steer of daily tylosin (Elanco Animal Health; Table 1). Urea was added to diets without WDGS to meet metabolizable protein requirements. Alfalfa hay was gradually replaced by DRC in 5 steps during a 21-d adaptation period. Inclusions of field peas at 20% and WDGS at 30% remained constant during each step so that only alfalfa and DRC were changing.

Cattle were fed once daily at approximately 0800 h, and bunks were managed so only traces of feed remained at feeding time. Refused feed was removed from bunks as needed, weighed, and dried in a forced-air oven for 48 h at 60°C for DM determination (AOAC, 1990; Method 935.29). Samples of each feed ingredient were collected weekly and analyzed for DM and a portion of these samples were composited by month for subsequent analysis and calculation of dietary CP, ether extract, NDF, and sulfur. Feed ingredients were analyzed according to the following procedures: CP (AOAC Method 990.03), ether extract (AOAC Method 920.39), NDF (Ankom Technology, Fairport, NY), starch (Xiong et al., 1990), and sulfur (AOAC Method 968.08). The nutrient composition (DM basis) of the field peas used in this study was 89.6% DM, 23.4% CP, 14.0% NDF, 1.2% ether extract, 49.7% starch, and 0.24% sulfur. The WDGS used in this study was (DM basis): 33.1% DM, 30.9% CP, 37.4% NDF, 10.9% ether extract, and 0.52% sulfur.

Cattle were implanted with Revalor-XS (Merck Animal Health) on d 1. Cattle in the heavy BW block were slaughtered on d 141, with the remainder slaughtered on d 160 at Cargill Meat Solutions (Fort Morgan, CO). Carcass data were collected by Diamond T Livestock Services (Yuma, CO). Hot carcass weight and liver scores were recorded on day of slaughter, whereas LM area, 12th-rib fat thickness, and USDA called marbling score were collected after a 48-h chill. A constant KPH of 2.5% was assumed and used in the YG calculation of Boggs and Merkel (1993). A common dressing percent (63%) was used to calculate final BW, ADG, and G:F from HCW.

Data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) as a 2 × 2 factorial with pen as the experimental unit. The model included the fixed effects of block, peas, WDGS, and peas × WDGS interaction. If a significant ($P < 0.05$) interaction was not detected, main effects were analyzed. In cases of a significant interaction, simple effects are presented and discussed. There was a small (3 kg) significant difference in initial BW for the main effect of peas, so initial BW was used as a covariate in the model. Effects were considered significant at a P-value of ≤0.05, with tendencies declared at P-values between 0.05 and 0.10.

Exp. 2

The grazing experiment was conducted over 2 yr. In yr 1, 108 conti-

Table 1. Composition of diets (% of diet DM) containing 0 or 20% field peas and 0 or 30% wet distillers grains plus solubles (WDGS) in Exp. 1

	Treatment[1]			
	0 Peas		20 Peas	
Item	0WDGS	30WDGS	0WDGS	30WDGS
Dry-rolled corn	86.5	56.5	66.5	36.5
Field peas	—	—	20.0	20.0
WDGS	—	30.0	—	30.0
Alfalfa hay	7.5	7.5	7.5	7.5
Supplement[2]				
Urea	1.07	—	0.40	—
Limestone	1.34	1.34	1.34	1.34
Potassium chloride	0.30	—	—	—
Salt	0.300	0.300	0.300	0.300
Rumensin-90[3]	0.016	0.016	0.016	0.016
Tylan-40[4]	0.009	0.009	0.009	0.009
Nutrient composition[5]				
DM	85.2	57.6	85.6	57.8
CP	11.5	15.2	12.6	18.2
NDF	10.7	19.7	12.0	21.0
Ether extract	2.77	5.08	2.39	4.70
Sulfur	0.14	0.25	0.16	0.27
Starch	62.5	41.6	57.9	37.2

[1]0WDGS = 0% WDGS plus 0 or 20% field peas, 30WDGS = 30% WDGS plus 0 or 20% field peas.

[2]Liquid supplement formulated to be fed at 6% diet DM, to provide: 50 mg/kg of Fe, 30 mg/kg of Zn, 20 mg/kg of Mn, 10 mg/kg of Cu, 0.5 mg/kg of I, 0.1 mg/kg of Co, 0.1 mg/kg of Se, 1,000 IU of vitamin A, 125 IU of vitamin D, 1.5 IU of vitamin E.

[3]Premix contained 176 g of monensin·kg^{-1} (Elanco Animal Health, Greenfield, IN).

[4]Premix contained 88 g of tylosin·kg^{-1} (Elanco Animal Health).

[5]Composition based on analyzed nutrients for each ingredient.

nental crossbred yearling heifers (initial BW = 338 ± 14 kg) were used in a randomized complete block designed grazing trial at the High Plains Agricultural Laboratory (**HPAL**) near Sidney, Nebraska. The heifers were sourced from a single operation. Vaccination against clostridial and viral pathogens and anthelmintic control were administered before arrival at HPAL. Heifers were weighed 2 consecutive days with the average of the 2 weights used as initial BW. They were blocked by d 0 BW, stratified by BW within block, and assigned randomly to one of nine 42.5-ha pastures (12 animals/pasture). Heifers grazed from June 22 to October 5, 2010. In yr 2, 90 crossbred beef steers (initial BW = 321 ± 10 kg) were used in a complete randomized design in the same pastures as yr 1 (10 animals/pasture). Prior to initiation of the trial, steers were limit fed 50% silage, 25% wet distillers grains, and 25% alfalfa hay on a DM basis at 2% BW for 5 d. Steers were then weighed 2 consecutive days, stratified by d 0 BW, and assigned randomly within strata to pasture. The average of the 2-d weights was used for initial weight. Steers were implanted with Revalor G (Merck Animal Health), vaccinated on d 0 with a modified live virus vaccine for the prevention of infectious bovine rhinotracheitis, bovine viral diarrhea types I & II, PI3, and bovine respiratory syncytial virus (Bovi-Shield Gold 5, Pfizer Animal Health, New York, NY) and for the prevention of *Clostridium chauvoei*, *septicum*, *novyi*, *sordellii*, *perfringens* types C & D, *Moraxella bovis*, and *Haemophilus somnus* (Vision-7 Somnus, Merck Animal Health), and treated with a parasiticide (Ivomec pour-on, Merial, Duluth, GA). At the termination of the grazing period steers were again limit fed the same diet at 2% BW for 5 d and the average of 2 consecutive day weights were used as the ending weight. Steers began grazing May 17, 2011, and the second day final weight was taken September 7, 2011.

In yr 1 and 2, pastures were assigned randomly to 1 of 3 treatments. Three pastures were assigned to each treatment. Treatments were DDGS fed on the ground (**GROUND**), DDGS fed in a bunk (**BUNK**), or a 25% field pea, 75% DDGS cube fed on the ground (**CUBE**). Samples of the supplements were analyzed by Servi-Tech Laboratories (Hastings, NE) before trial initiation for CP, NDF, Ca, and P content. The amount of supplement fed was designed to supply 0.27 kg of CP daily (Table 2). The variation in the CP content of the field pea/DDGS cube between years is likely due to variation in the CP content of field pea varieties as noted by Reichart and MacKenzie (1982) and Soto-Navarro et al. (2012). The weekly amount of supplement was prorated and fed 3 times per week. Cattle were rotated through the 9 pastures every 2 wk to minimize pasture effect. Forage samples were randomly clipped (August 17, 2010, and July 5, 2011) at ground level, lyophilized using a Virtis Freezemobile model 25 SL (Virtis, Gardiner, NY), and ground through a 1-mm screen in a Wiley mill (Thomas Scientific, Swedesboro, NJ). Digestibility of the forage samples was determined by IVDMD (Tilley and Terry, 1963), modified by the addition of 1 g/L of urea to the buffer (Weiss, 1994). Crude protein was determined by AOAC Method 990.03.

The NRC (1996) was used to estimate waste of the loose DDGS fed on the ground. Using BUNK ADG (0.70 kg/d), DDGS fed (0.9 kg/d), and the TDN of the forage and DDGS (58 and 110%, respectively), forage intake was predicted. Estimated TDN of

Table 2. Crude protein content and amount of supplements fed (DM basis) to cattle grazing crested wheatgrass pastures in Exp. 2

Item	DDGS[1]	CUBE[2]
% CP		
Yr 1 (2010)	30.7	20.6
Yr 2 (2011)	30.7	27.1
Amount fed (kg/animal per day)		
Yr 1 (2010)	0.91	1.4
Yr 2 (2011)	0.91	1.0

[1]Dry distillers grains with solubles (DDGS) fed loose in a bunk or on the ground.

[2]25% field pea, 75% DDGS cube fed on the ground.

DDGS was derived from Loy et al. (2008). Holding forage intake constant (7.6 kg/d) and using GROUND gain (0.61 kg/d), the amount of DDGS consumed to result in the decreased gain was predicted to be 0.67 kg/d.

Data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) as a randomized block design with pasture as the experimental unit. The model included the fixed effects of block, treatment, year, and treatment × year interaction. If a significant interaction was not detected, main effects were analyzed. Effects were considered significant at a P-value of ≤ 0.05, with tendencies declared at P-values between 0.05 and 0.10.

RESULTS AND DISCUSSION

Exp. 1

A significant peas × WDGS interaction ($P < 0.01$; Table 3) was observed for DMI, in which WDGS had no effect ($P = 0.07$) on DMI in diets with no peas, but increased DMI by 1.2 kg in diets containing peas ($P < 0.01$). Inclusion of peas decreased DMI by 0.6 kg in diets with no WDGS ($P < 0.01$), but had no effect ($P = 0.10$) on DMI in diets containing WDGS. The impact of field pea inclusion on DMI in finishing diets has not been consistent. The current study is in agreement with Lardy et al. (2009), who reported decreases in DMI due to pea inclusion when peas replaced a combination of DRC, high-moisture corn, and canola meal, and with Flatt and Stanton (2000), when peas replaced whole corn. No difference in DMI due to pea inclusion was observed by Loe et al. (2004) in lamb finishing diets, Lardy et al. (2009) in both DRC and barley based diets, and Jenkins et al. (2011) in DRC diets. Conversely, Fendrick et al. (2005) observed an increase in DMI at up to 40% inclusion of peas, but then a decrease at 59% of dietary DM replacing DRC, and Anderson (1999) observed an increase in DMI when peas replaced dry-rolled barley.

No interaction existed for ADG ($P = 0.82$). Similar to previous field pea research (Lardy et al., 2009; Jenkins et al., 2011), feeding peas had no effect on ADG ($P = 0.33$). As expected, WDGS improved ADG ($P < 0.01$), which is a common observation (Klopfenstein et al., 2008). A significant peas × WDGS interaction ($P < 0.01$) was observed for G:F, with WDGS increasing G:F by 12% in diets without peas ($P < 0.01$), but having no impact ($P = 0.12$) in diets containing peas. Feeding peas increased G:F ($P = 0.04$) in diets with no WDGS, as observed by Flatt and Stanton (2000), but decreased G:F ($P = 0.03$) in diets containing WDGS. However, more often, there has been no effect of peas on G:F (Loe et al., 2004; Lardy et al., 2009; Jenkins et al., 2011). Whereas all cattle fed field peas with or without WDGS were more efficient than those fed the corn control, feeding both 20% peas and 30% WDGS together did not result in an additive response, but rather, the performance of those cattle was intermediate to cattle fed only one or the other feedstuff. One hypothesis for this lack of an additive response is that by replacing corn as 50% of the diet DM with peas and WDGS, too much starch was replaced. It is widely accepted that starch is the main energy component of cereal grains, and that grains increase energy density of the diet (Huntington, 1997). So, in an effort to replace expensive corn with other feeds, some of which are lower in starch, cattle performance (i.e., G:F, ADG, fatness) may sometimes decrease. When Vander Pol et al. (2006) reduced corn grain inclusion to 40% of diet DM in a diet containing 50% WDGS, ADG, and G:F decreased compared with lower inclusions. In a study by Zinn et al. (1997), ADG and G:F also decreased as steam-flaked corn inclusion decreased to 41.9% of diet DM as cottonseed meal increased to 32%. These studies show decreased performance when relatively large amounts of corn are replaced by feeds that are lower in starch. The field peas fed in the current study contained 31% less starch than the DRC being replaced and WDGS contains roughly 3% starch. In the diet containing field peas and WDGS, DRC inclusion was only 36.5% of diet DM. The starch content of the diet containing both field peas and WDGS was the lower than any of the other diets (Table1). The lack of increased G:F in when WDGS was added to diets containing field peas may be a function of reduced dietary starch. Other research studying field peas in corn based diets without WDGS found the NE value of field peas to be similar to that of corn (Loe et al., 2004). The study by Lardy et al. (2009) observed a quadratic increase in diet NE_g as field pea inclusion increased. However, Fendrick et al. (2005) calculated lower NE_g values for field peas relative to corn at each inclusion level evaluated, up to 59% of diet DM. These differences in G:F response to increasing field pea inclusion are likely due to variation in nutrient content of the field pea vari-

Table 3. Performance and carcass characteristics of steers fed 0 or 20% field peas and 0 or 30% wet distillers grains plus solubles (WDGS)

	Treatment[1]							
	0 Peas		20 Peas			*P*-value		
Item	0WDGS	30WDGS	0WDGS	30WDGS	SEM	Peas[2]	WDGS[3]	Int.[4]
Performance								
Initial BW, kg	358	357	355	355	1	0.04	0.77	0.48
Final BW,[5] kg	635	677	632	672	8	0.32	<0.01	0.83
DMI, kg	11.3[b]	11.6[b,c]	10.7[a]	11.9[c]	0.3	0.30	<0.01	<0.01
ADG, kg	1.87	2.15	1.85	2.12	0.05	0.33	<0.01	0.82
G:F	0.165[a]	0.185[c]	0.172[b]	0.177[b,c]	0.002	0.96	<0.01	<0.01
Carcass trait								
HCW, kg	400	427	398	424	5	0.33	<0.01	0.80
Dressing %	62.4	63.5	62.2	63.5	0.1	0.60	<0.01	0.52
Marbling score[6]	591[a]	574[a,b]	566[b]	591[a]	8	0.30	0.72	0.01
LM area, cm^2	85.3	85.6	84.9	84.6	0.8	0.37	1.0	0.66
12th-rib fat, cm	1.52	1.65	1.52	1.70	0.01	0.40	<0.01	0.25
Calculated YG[7]	3.54	3.86	3.51	3.95	0.05	0.54	<0.01	0.24
Liver abscesses, %	16.2	10.4	11.5	8.1	3.8	0.38	0.23	0.75

[a–c]Means with different superscripts are different (*P* < 0.05).

[1]0WDGS = 0% WDGS plus 0 or 20% field peas, 30WDGS = 30% WDGS plus 0 or 20% field peas.

[2]Peas = main effect of field pea inclusion.

[3]WDGS = main effect of WDGS inclusion.

[4]Int. = field peas × WDGS interaction.

[5]Calculated from HCW, adjusted to a 63% common dressing percent.

[6]400 = Slight^0, 500 = Small^0.

[7]YG = [2.5 + (6.35 × fat thickness, cm) + (0.2 × 2% KPH) + (0.0017 × HCW, kg) – (2.06 × LM area, cm^2)]; (Boggs and Merkel, 1993).

ety fed, and variation in the nutrient composition of the basal diets being evaluated.

A significant peas × WDGS interaction ($P = 0.01$) was observed for marbling score, as feeding WDGS decreased marbling score when peas were not included in the diet, but increased marbling score in diets containing peas. However, the magnitude of these differences was small, with cattle in all treatments averaging USDA Choice QG. The inclusion of 20% field peas had no impact ($P \geq 0.30$) on carcass characteristics. The inclusion of 30% WDGS increased HCW, dressing percent, 12th-rib fat depth, and calculated yield grade ($P < 0.01$). No differences ($P = 0.99$) were observed for LM area when WDGS were fed. These results agree with the common observation that cattle fed WDGS gain more rapidly, and thus are fatter at equal days on feed (Klopfenstein et al., 2008).

Data from the current experiment suggest that field peas can be used as a replacement for a portion of the corn in finishing diets. Inclusion of 20% field peas improved G:F by 4% in DRC-based diets. When 50 percentage units of the DRC were replaced with a combination of field peas and WDGS, G:F was still significantly improved over the DRC control.

Table 4. Performance of cattle grazing crested wheatgrass pastures supplemented with dry distillers grains with solubles (DDGS) on the ground or in a bunk or a 25% field pea, 75% DDGS cube on the ground, Exp. 2

Item	GROUND	BUNK	CUBE[1]	SE
Initial weight, kg	334	335	333	11
Final weight, kg	400[a]	410[b]	409[b]	11
Daily gain, kg/d	0.61[a]	0.70[b]	0.71[b]	0.07

[a,b]Values with differing superscripts differ, *P* < 0.01.

[1]GROUND = DDGS fed loose on the ground, BUNK = DDGS fed in a bunk, CUBE = 25% field pea, 75% DDGS cube fed on the ground.

Exp. 2

The year × treatment interaction was not significant ($P > 0.13$) for

Table 5. Crude protein and IVDMD of clipped samples from crested wheatgrass pastures, Exp. 2

Date	CP, % DM	IVDMD, % DM
August 17, 2010[1]	4.8	46.7
July 5, 2011	6.9	56.0

[1]Samples clipped at approximately the midpoint of the grazing season.

initial BW, final BW, and ADG, so the main effect of treatment is presented. By design, initial BW was not different ($P > 0.50$; Table 4). Conversely, final BW and ADG were less ($P < 0.01$) for steers supplemented GROUND compared with CUBE and BUNK, which were not different. The difference in ADG between GROUND and BUNK is supported by Musgrave et al. (2012), who also found ADG to be greater for cattle fed loose DDGS in a bunk compared with on the ground. These authors estimated the loss of DDGS on the ground to be 36 to 41%. In the current study, a 25.6% loss in DDGS when fed loose on the ground was estimated from calculations previously described. The similar performance of CUBE and BUNK suggests the field pea served as an acceptable binder for the DDGS to reduce supplement waste. These data are in agreement with the recommendation of Anderson et al. (2007) that field peas included at 20 to 60% of the cube DM produce high-quality range cubes. Feeding supplement in a bunk reduces supplement waste but typically will cause overgrazing near the feeders. Costs associated with purchasing and moving bunks are incurred. As a result, many producers prefer to feed supplement on the ground, moving cattle throughout the pasture promotes more uniform grazing (Bailey and Welling, 1999).

Additionally, Soto-Navarro et al. (2012) determined the in situ degradable CP (% of CP) was 46 to 74% for several field pea varieties. Conversely, the UIP fraction as a percentage of CP is 73% (NRC, 1996) for DDGS. Therefore, the combination of field peas and DDGS in a range cube may supply a good balance of UIP and DIP on dormant native range.

Crude protein and digestibility of the crested wheatgrass are shown in Table 5. The CP and IVDMD of the crested wheatgrass were greater in the second year due to an earlier collection date and a greater amount of precipitation. The values for CP and IVDMD are consistent with medium- to low-quality forage reported by others (Bodine and Purvis, 2003; Morris et al., 2005; Jenkins et al., 2009) and cattle performance was similar to other studies supplementing a similar amount of DDGS (Morris et al., 2005; Jenkins et al., 2009; Griffin et al., 2012). The results of this study suggest that combining field peas and DDGS makes an acceptable range cube that reduces waste.

IMPLICATIONS

Up to 50% DRC can be replaced by field peas and WDGS in a finishing diet resulting in similar performance to DRC when these alternative feeds can be obtained competitively relative to corn. Field peas and WDGS are suitable energy sources in DRC-based finishing diets.

Field peas are an acceptable binder for DDGS-based range cubes. A 25% field peas, 75% DDGS range cube can be fed on the ground as a protein supplement to grazing cattle with minimal wastage. This would potentially allow producers to use supplementation to improve grazing distribution without the labor and expense of using bunks.

LITERATURE CITED

Anderson, V. L. 1999. Field peas in diets for growing and finishing steer calves. NDSU Carrington Research Extension Center Beef and Bison Field Day Proceedings. 22:9–15.

Anderson, V. L., G. P. Lardy, and B. R. Ilse. 2007. Review: Field pea grain for beef cattle. Prof. Anim. Sci. 23:1–7.

AOAC. 1990. Official Methods of Analysis. 15th ed. Assoc. Off. Anal. Chem., Arlington, VA.

Bailey, D. W., and G. R. Welling. 1999. Modification of cattle grazing distribution with dehydrated molasses supplement. J. Range Manage. 52:575–582.

Bodine, T. N., and H. T. Purvis II.. 2003. Effects of supplemental energy and/or degradable intake protein on performance, grazing behavior, intake, digestibility, and fecal and blood indices by beef steers grazed on dormant native tallgrass prairie. J. Anim. Sci. 81:304–317.

Boggs, D. L., and R. A. Merkel. 1993. Beef carcass evaluation, grading, and pricing. Pages 101–105 in Live Animal Carcass Evaluation and Selection Manual. D. L. Boggs and R. A. Merkel, ed. Kendall/Hunt Publishing Co., Dubuque, IA.

Buttrey, E. K., F. T. McCollum III, K. H. Jenkins, J. M. Patterson, B. E. Clark, M. K. Luebbe, T. E. Lawrence, and J. C. MacDonald. 2012. Use of dried distillers grains throughout a beef production system: Effects on stocker and finishing performance, carcass characteristics, and fatty acid profile of beef. J. Anim. Sci. 90:2381–2393. http://dx.doi.org/10.2527/jas.2011-4807.

Fendrick, E. M., I. G. Rush, D. R. Brink, G. E. Erickson, and D. D. Baltensperger. 2005. Effects of field peas in beef finishing diets. Nebraska Beef Report MP83-A:49–50.

Flatt, W. R., and T. L. Stanton. 2000. Effect of Profi Pea, *Pisum arvense*, on growth performance and carcass characteristics of feedlot cattle. Colorado State University Animal Science Department Report 18:81–84.

Griffin, W. A., V. R. Bremer, T. J. Klopfenstein, L. A. Stalker, L. W. Lomas, J. L. Moyer, and G. E. Erickson. 2012. A meta-analysis evaluation of supplementing dried distillers grains plus solubles to cattle consuming forage-based diets. Prof. Anim. Sci. (Accepted).

Haynes, R. J., R. J. Martin, and K. M. Goh. 1993. Nitrogen fixation, accumulation of soil nitrogen and nitrogen balance for some field-grown legume crops. Field Crops Res. 35:85–92.

Huntington, G. B. 1997. Starch utilization by ruminants: From basics to the bunk. J. Anim. Sci. 75:852–867.

Jenkins, K. H., J. C. MacDonald, F. T. McCollum III, and S. A. Amosson. 2009. Effects of level of supplementary dried distiller's grains on calves grazing native pastures and subsequent wheat pasture performance. Prof. Anim. Sci. 25:596–604.

Jenkins, K. H., J. T. Vasconcelos, J. B. Hinkle, S. A. Furman, A. S. de Mello Jr., L. S. Senaratne, S. Pokharel, and C. R. Calkins. 2011. Evaluation of performance, carcass characteristics, and sensory attributes of beef from finishing steers fed field peas. J. Anim. Sci. 89:1167–1172.

Klopfenstein, T. J., G. E. Erickson, and V. R. Bremer. 2008. BOARD INVITED

REVIEW: Use of distillers by-products in the beef cattle feeding industry. J. Anim. Sci. 86:1223–1231.

Lardy, G. P., B. A. Loken, V. L. Anderson, D. M. Larson, K. R. Maddock-Carlin, B. R. Ilse, R. Maddock, J. L. Leupp, R. Clark, J. A. Paterson, and M. L. Bauer. 2009. Effects of increasing field pea (*Pisum sativum*) level in high-concentrate diets on growth performance and carcass traits in finishing steers and heifers. J. Anim. Sci. 87:3335–3341.

Loe, E. R., M. L. Bauer, G. P. Lardy, J. S. Caton, and P. T. Berg. 2004. Field pea (*Pisum sativum*) inclusion in corn-based lamb finishing diets. Small Rumin. Res. 53:39–45.

Loy, T. W., T. J. Klopfenstein, G. E. Erickson, C. N. Macken, and J. C. MacDonald. 2008. Effects of supplemental energy source and frequency on growing calf performance. J. Anim. Sci. 86:3504–3510.

Morris, S. E., T. J. Klopfenstein, D. C. Adams, G. E. Erickson, and K. J. Vander Pol. 2005. The effects of dried distillers grains on heifers consuming low or high quality forage. Nebraska Beef Cattle Report. MP83-A:18–19.

Musgrave, J. A., L. A. Stalker, T. J. Klopfenstein, and J. D. Volesky. 2012. Comparison of feeding dry distillers grains in a bunk or on the ground to cattle grazing subirrigated meadow. Nebraska Beef Cattle Report. MP95:51–52.

National Agricultural Statistics Service. 2009. Crop Production 2008 Summary. Accessed Mar. 27, 2011. http://usda01.library.cornell.edu/usda/nass/CropProdSu//2000s/2009/CropProdSu-01-12-2009.pdf.

NRC. 1996. Nutrient Requirements of Beef Cattle. Update 2000. Natl. Acad. Press, Washington, DC.

Reichart, D. R., and S. L. MacKenzie. 1982. Composition of peas (*Pisum sativum*) varying widely in protein content. J. Agric. Food Chem. 30:312–317.

Soto-Navarro, S. A., M. Encinias, M. L. Bauer, G. P. Lardy, and J. S. Caton. 2012. Feeding value of field pea as a protein source in forage-based diets fed to beef cattle. J. Anim. Sci. 90:585–591.

Tilley, J. M. A., and R. A. Terry. 1963. A two-stage technique for the in vitro digestion of forage crops. J. Br. Grassl. Soc. 18:104–111.

Vander Pol, K. J., G. E. Erickson, T. J. Klopfenstein, and T. Robb. 2006. Effect of dietary inclusion of wet distillers grain on feedlot performance of finishing cattle and energy value relative to corn. Nebraska Beef Cattle Report. MP88-A:51–53.

Vasconcelos, J. T., and M. L. Galyean. 2007. Nutritional recommendations of feedlot consulting nutritionists: The 2007 Texas Tech University survey. J. Anim. Sci. 85:2772–2781.

Walley, F. L., G. W. Clayton, P. R. Miller, P. M. Carr, and G. P. Lafond. 2007. Nitrogen economy of pulse crop production in the northern Great Plains. Agron. J. 99:1710–1718. http://dx.doi.org/10.2134/agronj2006.0314s.

Weiss, W. P. 1994. Estimation of digestibility of forages by laboratory methods. Pages 644–681 inForage Quality, Evaluation, and Utilization. G. C. Fahey Jr., ed. Am. Soc. Agron., Crop Sci. Soc. Am., and Soil Sci. Soc. Am., Madison, WI.

Xiong, Y., S. J. Bartle, and R. L. Preston. 1990. Improved enzymatic method to measure processing degree and the availability of starch in sorghum grain. J. Anim. Sci. 68:3861–3870.

Zinn, R. A., M. Montano, E. Alvarez, and Y. Shen. 1997. Feeding value of cottonseed meal for feedlot cattle. J. Anim. Sci. 75:2317–2322.