The Professional Animal Scientist 31 (2015):552–558; http://dx.doi.org/10.15232/pas.2015-01439

Effects of alkaline treatment and pelleting of crop residues on performance of growing calves[1]

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ABSTRACT

Two experiments used 2 × 2 factorial arrangements of treatments to determine effects of pelleting and alkaline treatment of residues on performance of growing steers. In Exp. 1, 480 steers (initial BW = 312 kg; SD = 16) were used to evaluate pelleting the diet and alkaline treatment of corn residue (5% CaO + H_2O or 6.6% calcium hydroxide vs. none). In Exp. 2, 460 steers (initial BW = 331 kg; SD = 20) were used to evaluate alkaline treatment (5% CaO + H_2O vs. none) and residue type (corn residue vs. wheat straw). In Exp. 1, no interaction between alkaline treatment and pelleting was observed ($P \geq 0.18$). Pelleting increased DMI and ADG ($P < 0.01$) but reduced G:F ($P < 0.01$). Alkaline treatment increased DMI, ADG ($P < 0.01$), and G:F ($P < 0.05$). In Exp. 2, an interaction between crop residue and alkaline treatment was observed for ending BW and ADG ($P < 0.01$). Steers fed treated corn residue had 9.2% greater ADG and 1.1% greater ending BW when compared with steers fed untreated corn residue, whereas steers fed treated wheat straw diets had increases of 25.7% for ADG and 3.4% for ending BW compared with steers fed untreated wheat straw. Wheat straw increased DMI by 8% ($P < 0.01$) and improved G:F by 5% ($P = 0.05$) when compared with corn residue diets. Alkaline treatment improved G:F by 6.4% ($P = 0.03$) and increased DMI by 9.6% ($P < 0.01$). Overall, pelleting increased DMI and ADG but reduced G:F, whereas alkaline treatment increased ADG and G:F.

Key words: alkaline treatment, pelleting, corn residue, wheat straw, growing calf

INTRODUCTION

High corn prices from 2007 to 2013 negatively affected forage supply because land historically used for forage production was converted to corn (Wright and Wimberly, 2013). However, increased grain production is paired with increased availability of crop residues (Klopfenstein, 1978). Although replacement of higher quality forage sources with corn residue may be less expensive, digestibility is low because of plant maturity at the time of grain harvest. Therefore, the feeding value of crop residues needs to increase to effectively offset the forage lost from land conversion.

Feeding values of low-quality forages can be improved via alkaline treatment by increasing the rate and extent of cellulose and hemicellulose digestion (Klopfenstein, 1978). Improved feeding value may be attributed to swelling of the forage, thereby allowing microbial attachment (Tarkow and Feist, 1968), which results in increased digestibility compared with untreated residues (Shreck et al., 2011, 2015).

Processes that decrease particle size, such as grinding and pelleting, increase total surface area, allowing for faster microbial attachment (Bowman and Firkins, 1993). Additionally, decreasing particle size increases particle density, which allows for continued flow from the rumen to the small intestine shortly after ingestion (Hooper and Welch, 1985). However, increased rates of passage can limit the time allowed for fiber digestion (Pearce and Moir, 1964), although increased intakes may compensate for decreased digestibility (Van der Honing, 1975). Reducing particle size before calcium oxide treatment improves the feeding value of chemically treated forages (Shreck et al., 2012). However, little

[1] This was a contribution of the University of Nebraska Agricultural Research Division, supported in part by funds provided through the Hatch Act. The authors acknowledge Iowa Agricultural BioFibers, Harlan, Iowa, for donating a portion of the feed used in this research.

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Table 1. Ingredient composition of diets fed to growing calves in Exp. 1

	Pelleted		Unpelleted	
Item	Untreated	$Ca(OH)_2$[1]	Untreated	CaO[1]
Ingredient, DM %				
MDGS/DDGS[2]	36	36	36	36
Treated residue[3,4]	—	60	—	60
Untreated residue[3,4]	60	—	60	—
Supplement	4	4	4	4
Fine ground corn	2.4064	3.5234	2.4064	3.5234
Limestone	1.1170	—	1.1170	—
Salt	0.3000	0.3000	0.3000	0.3000
Tallow	0.1000	0.1000	0.1000	0.1000
Trace mineral	0.0500	0.0500	0.0500	0.0500
Vitamin A-D-E	0.0150	0.0150	0.0150	0.0150
Rumensin[5]	0.0116	0.0116	0.0116	0.0116
Nutrient composition, % of DM				
CP	15.79	16.23	14.76	14.79
NDF	55.44	50.17	60.16	55.06
Ca	0.88	1.60	0.31	2.00
P	0.42	0.40	0.39	0.40
NDF digestibility				
NDF,[6] %	56.9	50.2	82.6	77.7
IVNDFD,[7] %	34.5	39.7	45.1	50.7

[1]Unpelleted residue treated with 5% CaO (DM basis) after hydration with water to 50% DM at least 7 d before feeding. Pelleted residue treated with 6.6% $Ca(OH)_2$ in place of CaO, which provided the same hydroxide units as 5% CaO. Approximately 50% of this residue was treated with a moisture content of 35% before being blended with the remainder of the residue and pelleted.

[2]Unpelleted diets contained modified distillers grains plus solubles (MDGS), whereas pelleted diets contained dried distillers grains plus solubles (DDGS).

[3]Pelleted residue was treated with 6.6% $Ca(OH)_2$ in place of 5% CaO.

[4]All baled corn residue originated from the same source.

[5]Formulated to provide 200 mg/d per steer of monensin (Elanco Animal Health, Greenfield, IN).

[6]NDF content of pellets or corn residue, DM basis.

[7]In vitro NDF disappearance of pellets or corn residue, 48-h incubation time.

work has evaluated pelleting and calcium oxide–treated forages in growing diets. Therefore, the objectives of this research were to evaluate the effects of (1) pelleting and alkaline treatment of corn residue and (2) alkaline treatment of wheat straw and corn residue on the performance of growing calves fed diets containing distillers grains.

MATERIALS AND METHODS

All procedures used for these experiments involving animal care were approved by the University of Nebraska–Lincoln Institutional Animal Care and Use Committee.

Exp. 1

Crossbred yearling steers (n = 480; BW = 312 kg; SD = 16) were used in an 80-d growing experiment to determine the effects of calcium oxide–treated corn residue and pelleting in diets containing distillers grains on growing calves. The experimental design was a generalized randomized block design with a 2 × 2 factorial arrangement of treatments. Factors included diets that were either pelleted (**PEL**) or unpelleted (**NPEL**) in combination with corn residue that was either alkaline treated (**TRT**) or residue that remained free of chemical treatment (**UNT**; Table 1).

Corn residue for all diets was purchased as round bales from the same source before the start of the experiment. Corn residue used for NPEL was tub ground (Mighty Giant, Jones Manufacturing, Beemer NE) through a 7.62-cm screen and stored in a covered commodity bay before initiation of the experiment. The chemical treatment of NPEL-TRT consisted of mixing CaO (5% of total DM; standard quicklime, Mississippi Lime Co., Kansas City, MO) and ground residue hydrated to 50% DM with water (Shreck et al., 2011). Feed trucks dispensed NPEL-TRT residue into a concrete bunker that was subsequently covered with plastic. This process was completed every 2 wk continuously throughout the trial so that residue treatment occurred at least 7 d before feeding. For both NPEL diets, all ingredients were weighed and mixed in a Roto-Mix feed truck (Dodge City, KS) and delivered to pens.

The PEL residues were processed at a commercial facility (Iowa Agricultural BioFibers, Harlan, IA). The PEL-UNT residue was ground, mixed with dried distillers grains plus solubles (**DDGS**) and supplement (Table 1), and pelleted. Because TRT residues were treated either at the research facility or at a commercial facility, the alkaline treatment differed slightly. At the commercial facility, the PEL-TRT residue was ground and treated with 6.6% $Ca(OH)_2$ in place of CaO, which was calculated to provide the same hydroxide units as 5% CaO. Approximately 50% of residue for PEL was treated with a moisture content of 35% before being blended with the remainder of the residue. The treated residue was mixed with DDGS and supplement and pelleted. Similarly, although all diets contained 36% distillers grains (Table 1), the NPEL diets contained modified corn distillers grains plus solubles to aid in palatability and binding of the diet, whereas the PEL diets contained DDGS to maintain efficacy of the pelleting process.