

Effects of Distillers Grains or Fiber on Enterohemorrhagic Escherichia coli in Steers

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Summary with Implications

Increased probability for fecal shedding and colonization by Escherichia coli O157:H7 has been observed in previous studies when steers are fed increased inclusions of distillers grains. A feeding study was conducted to determine if distillers grains or fiber from distillers grains in the finishing ration of feedlot steers affected fecal shedding prevalence of seven serogroups of enterohemorrhagic Escherichia coli (EHEC-7). For EHEC O45 and EHEC O103, the greatest prevalence of shedding occurred when steers were fed increased distillers grains. For all EHECs except for O111, fecal shedding prevalence was similar between the corn control and either of the corn fiber isolate diets. Decreased prevalence for shedding O111 was observed in steers fed increased distillers grains at higher fiber level compared to steers fed corn fiber isolate diets. Dietary treatment did not impact EHEC O145 or EHEC O157 shedding. These data suggest that dietary factors affecting EHEC fecal shedding differ by serogroup.

Introduction

Enterohemorrhagic *Escherichia coli* (EHEC) are important foodborne pathogens capable of causing severe human illness. Cattle populations are known to be important reservoirs for EHEC. There are seven serogroups of EHEC (EHEC-7) that have been declared adulterants in raw beef by USDA FSIS that include: O26,

O45, O103, O111, O121, O145, and O157. Distillers grains are used frequently in the finishing ration of feedlot cattle. Previous studies have shown that increased inclusion of distillers grains (40 to 50% DM) in the finishing diet increased probability for colonization (*Journal of Food Protection*, 2007; 70:2568) and fecal shedding (*Applied and Environmental Microbiology*, 2010, 76:8238) of *E. coli* O157:H7 compared to feeding a control corn diet or 20% DM distillers grains; however, the mechanism by which this occurs is not understood (*Journal of Food Protection*, 2007; 70:2568; *Applied and Environmental Microbiology*, 2010, 76:8238). The objective of this study was to determine whether the presence of distillers grains in the diet explains the probability to detect the seven serogroups of EHEC in the feces of feedlot steers, and if this is primarily caused by changes in dietary fiber that occur when distillers grains are fed.

Procedures

The study was a 2 x 2 plus 1 factorial design within a randomized block design. There were two inclusions of modified distillers grains plus solubles (MDGS); two diets formulated with corn germ meal and corn bran to equal NDF content of the MDGS diets, and a corn control diet. A total of 100 pens of 800 steers (initial BW=915 lb; SD=53 lb) were fed during the summer of 2015 at the University of Nebraska-Lincoln Eastern Nebraska Research and Extension Center (ENREC). Two-day body weights were measured and steers were allocated into blocks according to BW. Within each of 4 blocks, 25 feedlot pens (n=8 steers/pen) were assigned randomly to the following diets: (1) corn control (CON); (2) 20% MDGS as % of diet DM (20MDGS); (3) 40% MDGS as % of DM (40MDGS); (4) corn fiber isolate

Table 1. Composition (% of diet DM) of dietary treatments fed to yearling steers.

Ingredient	Treatment ¹				
	CON	20MDGS	40MDGS	20FIB	40FIB
Dry-rolled corn	68.5	51.5	31.5	60	51.5
High-moisture corn	12	12	12	12	12
MDGS ²	-	20	40	-	-
SEM ³	-	-	-	1.5	3
Wet Corn Bran	-	-	-	7	14
Corn Silage	8	8	8	8	8
Alfalfa Hay	3.5	3.5	3.5	3.5	3.5
Supplement	8	5	5	8	8
Nutrient Composition, % of DM					
CP	14.1	15.1	19.8	14.1	13.3
NDF	11.0	16.7	22.0	16.6	22.2
ADF	4.5	6.6	8.6	6.0	7.5
Lignin	1.7	2.3	2.9	1.9	2.2

¹ Treatments included CON-control; 20MDGS-20% modified distillers grains plus solubles; 40MDGS-40% modified distillers grains plus solubles; 20FIB-fiber fed from concentrated ingredients to mimic fiber provided by 20MDGS; 40FIB-fiber fed from concentrated ingredients to mimic fiber provided by 40MDGS.

² MDGS: Modified distillers grains plus solubles,

³ SEM: solvent extracted germ meal

Table 2. Mean pen-level prevalence (SE_p) of EHEC serogroups detected in fecal samples from 800 feedlot steers during each sampling period.

EHEC Serogroup	Sampling Period			
	d0	d35	d70	d105
EHEC O26	0.5% (0.3)	0%	0%	0%
EHEC O45	26% (1.6)	2.5% (0.6)	2.3% (0.5)	3.9% (0.7)
EHEC O103	32% (1.7)	27% (1.6)	16% (1.3)	13% (1.2)
EHEC O111	0.5% (0.3)	8.5% (1.0)	22% (1.5)	19% (1.4)
EHEC O121	62% (1.7)	0.1% (0.1)	0%	0%
EHEC O145	6.6% (0.9)	3.4% (0.6)	2.3% (0.5)	3.8% (0.7)
EHEC O157	16% (1.3)	4.1% (0.7)	4% (0.7)	4.1% (0.7)

¹EHEC: Enterohemorrhagic *Escherichia coli*

²SE_p: Standard Error of the proportion; calculated as: sqrt [p(1-p)/n]

Table 3. Unadjusted prevalence (SE_p) of EHEC shedding among steers by sampling period, NDF level, and presence or absence of MDGS in the diet.

DIET		EHEC O45	EHEC O103	EHEC O111	EHEC O145	EHEC O157
70d						
NDF ¹ 11						
CON	MDGS ² 0	1.9% (1.1)	12.5% (2.6)	25.6% (3.5)	0.6% (0.6)	1.9% (1.1)
NDF 17						
20FIB	MDGS 0	0.6% (0.6)	6.9% (2.0)	34.4% (3.8)	0.6% (0.6)	3.8% (1.5)
20MDGS	MDGS 1	0.6% (0.6)	13.8% (2.7)	25% (3.4)	2.5% (1.2)	5.0% (1.7)
NDF 22						
40FIB	MDGS 0	1.9% (1.1)	10.6% (2.4)	19.4% (3.1)	3.1% (1.4)	2.5% (1.2)
40MDGS	MDGS 1	6.3% (1.9)	36.3% (3.8)	5.0% (1.7)	4.4% (1.6)	5.6% (1.8)
105d						
NDF 11						
CON	MDGS 0	2.5% (1.2)	10.6 (2.4)	18.1% (3.1)	3.8% (1.5)	3.1% (1.4)
NDF 17						
20FIB	MDGS 0	0.6% (0.6)	7.5% (2.1)	11.9% (2.6)	4.4% (1.6)	4.4% (1.6)
20MDGS	MDGS 1	1.3% (0.9)	6.3% (1.9)	12.5% (2.6)	2.5% (1.2)	3.1% (1.4)
NDF 22						
40FIB	MDGS 0	3.8% (1.5)	13.1% (2.7)	31.9% (3.7)	5.0% (1.7)	3.8% (1.5)
40MDGS	MDGS 1	11.4% (2.5)	27.2% (3.5)	20.9% (3.2)	3.2% (1.4)	6.3% (1.9)

¹Treatments included CON-control; 20MDGS-20% modified distillers grains plus solubles; 40MDGS-40% modified distillers grains plus solubles; 20FIB-fiber fed from concentrated ingredients to mimic fiber provided by 20MDGS; 40FIB-fiber fed from concentrated ingredients to mimic fiber provided by 40MDGS.

²SE_p: Standard Error of the proportion; calculated as: sqrt [p(1-p)/n]

³EHEC: Enterohemorrhagic *Escherichia coli*

⁴NDF for CON was 11%, 20MDGS was 17% NDF, 20FIB was 17% NDF, 40MDGS was 22% NDF, 40FIB was 22% NDF

⁵MDGS coded as 0 for absent from the diet, 1 for present in the diet

added to match NDF of 20% MDGS diet (20FIB); and (5) corn fiber isolate to match NDF of 40% MDGS diet (40FIB) (2017 Nebraska Beef Report, pp. 90–92). The main dietary nutrient that fluctuated across treatments was dietary NDF. The diets contained 11.0, 16.7, 22.0, 16.6, or 22.2% NDF for CON, 20MDGS, 40MDGS, 20FIB, or 40FIB, respectively. Table 1 provides nutrient composition and description of diet composition. Fecal samples were collected individually from steers on d 0, 35, 70, and 105. EHEC-7 testing was performed using the NeoSEEK™ STEC Detection and Identification test (Neogen Corp., Lansing, MI). Fecal sample test results were recorded as presence or absence for each of the seven serogroups of EHEC.

The effects of MDGS, NDF, and sampling period on fecal shedding of EHEC-7 were evaluated. The absence or presence of MDGS within the diet was coded as a binary class variable, 0 or 1, respectively. Fiber (NDF) was included as a continuous variable, with NDF for steers fed CON assigned a value of 11, NDF for 20MDGS or 20FIB was assigned a value of 17, and NDF for 40MDGS or 40FIB was assigned a value of 22. Each EHEC serogroup was tested as a separate outcome variable.

Results

Mean pen-level prevalence of each serogroup are included in Table 2. Highest prevalence of every EHEC serogroup, except EHEC O111, was during sampling period 1. Cattle were adapted to finishing diets over a 21 d period (day 0 to 21), so only sampling periods at d70 and d105 were analyzed to determine effects of MDGS and NDF.

Table 3 provides the observed proportion of each EHEC serogroup detected in RAMS samples accounting for sampling period, MDGS, and NDF. There was greater prevalence of EHEC O45 at d105 (3.9%) than d70 (2.3%). The highest prevalence during either sampling period was found when steers were fed NDF 22% and MDGS was present (40MDGS diet). Similarly, for the outcome of EHEC O103, the highest prevalence of shedding was found in steers fed 22% NDF and MDGS. There was higher prevalence of EHEC O103 at d70 compared to d105. The highest prevalence of EHEC O111 observed throughout the entire study was at d70 (22%). At d70 the highest prevalence was

observed in steers fed 20FIB diet; however, at d105 the highest prevalence was seen in steers fed the 40FIB diet. There was a higher prevalence of EHEC O145 detected at d 105 (3.8%) than at d70 (2.3%). At d70 steers fed 40MDGS had higher prevalence of shedding, but at d105 steers fed 40FIB had higher prevalence of shedding. Similar EHEC O157 shedding prevalence was observed for 70 and d105, and steers fed 40MDGS had highest prevalence. Neither EHEC O26 nor EHEC O121 was detected in any fecal samples at d70 or d105.

Discussion

For EHEC O45, EHEC O103, EHEC O145 (at d70), and EHEC O157, the highest shedding prevalence was observed when cattle are fed 40% MDGS. This suggests that the increased risk for fecal shedding of EHEC by cattle on 40% MDGS diets was not due to higher fiber levels from distillers grains, but some other components of the ration contributed by MDGS. Compared to the other EHEC serogroups, different effects were observed regarding shedding prevalence of EHEC O111 in relation to fiber levels and presence of MDGS.

Conclusion

These results suggest that the dietary factors affecting fecal shedding are not the same for every EHEC serogroup.

Acknowledgement

This material is based upon work that is supported by the U.S. Department of Agriculture (USDA), National Institute of Food and Agriculture under award 2012-68003-30155.

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