2014

Using Enspira™ to Improve Fiber Digestion

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Summary

Two experiments evaluated the effect of treating various feedstuffs with an enzyme (Enspira) on digestibility. Twelve feeds commonly fed to beef cattle were treated with four levels of the enzyme (0, 0.25, 0.50, or 0.75 lb of enzyme per ton of DM). Enzyme treatment increased in vitro DMD of high moisture corn (HMC), wet distillers grains plus solubles (WDGS), corn bran, and husks. There was a quadratic increase in gas production for corn leaves, as well as a linear increase in gas production for corn bran treated with increasing levels of Enspira. Treating feeds with the commercial enzyme Enspira improved in vitro digestibility of feeds high in hemicellulose, but not all feeds.

Introduction

About one-third of corn production in the United States is used for ethanol production today. The utilization of corn in the production of ethanol, in addition to the current drought, has forced cattle producers to feed less corn. Non-traditional feeds like corn milling byproducts and low-quality forages are being used to replace corn in beef cattle diets. However, these feed alternatives are higher in fiber content compared to the corn they are replacing, thus resulting in more fiber-based diets. Therefore, if the digestibility of these fibrous components of cattle diets could be improved, cattle efficiencies could be increased. Enspira is a direct-fed enzyme designed to increase fiber (i.e., hemicellulose) digestion. It has been fed in pork and poultry diets and resulted in improved feed efficiency. However, it has not been tested in ruminant diets. Therefore, the objective of these two experiments was to investigate the use of Enspira on common feeds in beef cattle diets *in vitro* and determine the optimal dosage in cattle diets.

Procedure

Experiment 1

The first experiment was designed as a 4 x 11 x 2 factorial with threee replications per treatment. Factors were four levels of Enspira (0, 0.25, 0.50, 0.75 lb per ton of DM) and 11 commonly used feeds (Table 1) incubated for 24 or 48 hours. All samples were freeze-dried and ground through a 1-mm screen. Feeds were analyzed for IVDMD. The procedure involved weighing 0.5 g of sample into a 100 mL tube, treating the sample with one of the four levels of enzyme, and adding 50 mL of inoculum. Inoculum was obtained by collecting a mixture of rumen fluid, strained through cheesecloth, from two steers consuming a 30% concentrate/70% roughage diet. The strained ruminal fluid was then mixed with McDougall's buffer (1:1 ratio) containing 1 g urea/L. Test tubes were placed in a water bath at 101°F. Tubes were incubated for 24 or 48 hour. Fermentation was ended by adding 6 mL of 20% HCl and 2 mL of 5% pepsin solution per tube. Tubes were then placed in the water bath for another 24 hours. Residue was filtered, dried, and weighed to determine IVDMD. Data were analyzed using the mixed procedures of SAS (SAS Institute, Inc., Cary, N.C.). The response variable was IVDMD. Tube was the experimental unit and there were three tubes per treatment per incubation time.

Experiment 2

Experiment 2 was similar to that as described in Experunebt 1; however, gas production was measured using the ANKOM gas production system instead of IVDMD. Gas production bottles were limited to 12 bottles per run; therefore, 12 feeds were used (Table 1) and divided into four runs. The same 11 feeds were used as in Experiment 1 with the addition of beef pulp. Feeds were grouped within run as follows: low-, medium-,

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Table 1. Substrates utilized in Experiment 1 and Experiment 2.

Experiment 1	Experiment 2
Low-quality forage[1]	Low-quality forage[1]
Medium-quality forage[2]	Medium-quality forage[2]
High-quality forage[3]	High-quality forage[3]
Corn cobs	Corn cobs
Corn husks	Corn husks
Corn leaves	Corn leaves
Wheat straw	Wheat straw
Corn bran	Corn bran
Wet distillers grains plus solubles	Wet distillers grains plus solubles
Dry-rolled corn	Dry-rolled corn
High-moisture corn	High-moisture corn
—	Beet pulp

[1]50-55% TDN.
[2]55-50% TDN.
[3]60-65% TDN.

and high-quality forage; corn cobs, corn husks, and corn leaves; wheat straw, beet pulp, and wet distillers grains plus solubles; dry-rolled corn, corn bran, and high-moisture corn. Within each run, feeds were treated with 0, 0.25, and 0.50 lb/ton of DM of Enspira. The procedure involved weighing 1 g of sample into a 250 mL gas production bottle, treating the sample with one of the three levels of enzyme, and adding 100 mL of inoculum. Inoculum was prepared as described in Experiment 1. Gas production was measured continuously for 36 hours. Each group of feeds was run four times to ensure adequate experimental power. Data were analyzed using the mixed procedures of SAS. The response variables were total gas produced and the rate of gas produced. Bottle was the experimental unit.

Table 2. Effects of Enspira on *in vitro* DM digestion of various feedstuffs (24 hour; SE = 1.7).

	Enzyme Level				*P*-value		
Item	0.00	0.25	0.50	0.75	F-Test	Linear	Quad
HMC	90.0[ab]	91.6[a]	85.6[b]	86.8[b]	0.05	<0.01	0.66
DRC	89.9	90.7	89.2	87.5	0.57	0.07	0.16
WDGS	67.1	68.0	70.9	67.7	0.36	0.87	0.42
Bran	60.1[a]	59.9[a]	66.7[b]	66.4[b]	<0.01	0.01	1.0
Husks	49.6[a]	44.5[b]	39.6[c]	39.5[c]	<0.01	0.08	0.51
Leaves	32.1	32.7	30.0	28.8	0.31	0.01	0.23
Cobs	29.1[a]	28.0[a]	25.1[ab]	23.5[b]	0.07	<0.01	0.75
Low quality	41.8	41.0	41.5	39.2	0.68	0.04	0.36
Medium quality	44.3	42.8	42.5	43.1	0.89	0.54	0.46
High quality	52.5	52.5	51.8	52.3	0.99	0.94	0.87
Wheat straw	30.8	27.4	26.7	28.1	0.31	0.05	0.02

Table 3. Effects of Enspira on *in vitro* dry matter digestion of various feedstuffs (48 hour; SE = 1.7).

	Enzyme Level				*P*-value		
Item	0.00	0.25	0.50	0.75	F-Test	Linear	Quad
HMC	94.9	94.1	90.1	91.1	0.12	0.02	0.36
DRC	95.9	97.2	94.4	92.9	0.31	0.07	0.20
WDGS	72.5[a]	81.3[b]	75.2[a]	79.8[b]	<0.01	0.03	0.32
Bran	81.3[a]	85.9[b]	79.1[a]	80.8[a]	0.03	0.84	0.41
Husks	53.1[a]	62.9[b]	60.7[b]	62.0[b]	<0.01	0.17	0.34
Leaves	46.8[a]	46.8[a]	41.4[b]	42.8[ab]	0.05	<0.01	0.23
Cobs	43.3	45.3	41.1	42.3	0.34	0.36	0.61
Low quality	52.1	47.9	50.9	50.8	0.32	0.54	0.18
Medium quality	55.5	57.4	53.3	53.2	0.22	0.12	0.33
High quality	67.2	67.6	68.1	68.7	0.92	0.33	0.93
Wheat straw	41.6	42.7	40.9	40.2	0.74	0.29	0.33

Table 4. Effects of Enspira on total gas produced (mL/g of DM) on various feedstuffs.

	Enzyme Level				*P*-value		
Sample	0	0.25	0.50	SEM	F-Test	Linear	Quad
HMC	293.6[a]	310.1[b]	307.0[b]	2.42	0.01	0.01	0.02
DRC	301.2	295.7	291.7	8.42	0.74	0.46	0.94
Wheat straw	111.3	113.0	103.9	6.48	0.61	0.46	0.53
Poor brome	104.8	101.3	98.4	5.32	0.71	0.43	0.97
Good brome	133.6	134.0	133.8	12.44	1.0	0.99	0.98
High brome	158.9	163.4	156.9	20.25	0.97	0.95	0.83
Cob	115.70	115.01	122.03	13.67	0.92	0.75	0.83
Husk	198.53	197.12	201.73	6.51	0.88	0.74	0.72
Leaves	125.63	132.79	125.30	6.36	0.67	0.97	0.39
Beet pulp	198.05	189.12	197.90	4.84	0.41	0.98	0.21
WDGS	121.57	121.05	119.59	2.13	0.80	0.55	0.87
Corn bran	113.01	121.32	122.72	2.18	0.07	0.03	0.27

Results

Experiment 1

There was a feed*enzyme level interaction ($P < 0.01$). Digestibilities varied between feeds, which was to be expected. There was also a feed*enzyme*time interaction ($P < 0.01$), which was anticipated since different feeds digest at different rates. There was a linear increase in IVDMD at 24 hours of incubation, when corn bran was treated with increasing levels of Enspira (Table 2). However, a linear decrease (90% to 86.8% DMD) in digestibility was observed when increasing levels of enzyme were added to HMC ($P < 0.01$). Similarly, husk digestibilities ranged from 49.6% with no enzyme added to 39.5% at the highest level of enzyme added. Conversely, enzyme treatment improved IVDMD linearly ($P < 0.05$) for WDGS when incubated at 48 hours (Table 3). There was an improvement in digestibility at 48 hours of incubation when the enzyme was added to the husks; however, all levels of the enzyme responded the same. These results suggest that the enzyme is improving digestion of feeds that are higher in hemicellulose. It does not appear to improve digestibilities of feeds that are more cellulosic fiber. This response would be expected since Enspira contains a minimum of 350 U/g xylanase, which is the enzyme responsible for degrading hemicellulose.

Experiment 2

There was no feed*enzyme interaction ($P > 0.45$). Similar to Experiment 1 there was a significant difference between feeds for digestion; however, this was by design as digestibilities of the selected feeds ranged widely. Enzyme treatment improved the amount of total gas

Table 5. Effect of Enspira on gas production rate (mL/hour) on various feedstuffs in Experiment 2.

	Enzyme Level				*P*-value		
Sample	0	0.25	0.50	SEM	F-Test	Linear	Quad
HMC	8.15[a]	8.61[b]	8.53[b]	0.076	0.03	0.03	0.04
DRC	4.92	4.78	4.40	0.124	0.09	0.04	0.49
Wheat straw	6.53	6.57	6.58	0.138	0.96	0.81	0.93
Poor brome	3.22	3.05	1.91	0.687	0.42	0.25	0.60
Good brome	4.14	4.13	4.14	0.078	1.0	1.0	0.95
High brome	4.96	5.07	4.89	0.810	0.57	0.68	0.36
Cob	3.22	3.19	3.39	0.211	0.78	0.59	0.68
Husk	5.51	5.48	5.60	0.072	0.51	0.43	0.42
Leaves	3.49	3.69	3.48	0.053	0.08	0.93	0.04
Beet pulp	5.50	5.26	5.50	0.134	0.41	1.0	0.21
WDGS	3.38	3.36	3.32	0.057	0.79	0.52	0.91
Corn bran	3.14	3.37	3.41	0.062	0.07	0.04	0.28

produced when applied to HMC (Table 4). This improvement was a quadratic response as gas production increased to 0.25 lb per ton of DM application rate and was constant as enzyme increased to 0.50 lb per ton of DM ($P < 0.05$). Similarly, rate of gas production linearly increased as the enzyme treatment was applied to the HMC ($P < 0.05$). Rate of gas production also linearly increased (Table 5) when the enzyme was applied to corn bran ($P < 0.05$). Conversely, there was a linear decrease ($P < 0.05$) in rate of gas production when the commercial enzyme was added to DRC. There was a quadratic response when treating corn leaves with the enzyme ($P < 0.05$). The effect of the enzyme on the digestion of feeds is variable between Experiment 1 and 2. In Experiment 1, the enzyme had a negative impact on the IVDMD of HMC; however, the enzyme treatment caused an improvement in gas production when applied to HMC in Experiment 2.

Implications

In conclusion, the impact of the enzyme on various feedstuffs is highly variable. Data from these two studies suggest the optimum level of enzyme is 0.25 lb per T of DM. Enspira has the potential to be used to improve digestibility of high hemicellulose feeds in beef cattle diets. This could improve efficiency of the cattle consuming the higher fiber based diets that are being fed today.

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