Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 1484

2010

Effects of SmartLic Hi-Pro 40 block supplements on ruminal microbes in cattle fed low-quality forages

K.D. Derstein

James S. Drouillard

Effects of SmartLic Hi-Pro 40 Block Supplements on Ruminal Microbes in Cattle Fed Low-Quality Forages[1]

K.D. Derstein and J.S. Drouillard

Introduction

Dormant pastures and native grass hays often are deficient in protein and other nutrients needed to support optimum performance of beef cattle. These nutrients are essential for maintaining viable populations of symbiotic rumen microorganisms that digest the fiber in forages. When nutrient deficiencies occur, microbial populations in the rumen decrease, thereby limiting digestion of low-quality forages. This study was conducted to evaluate changes in rumen microbial populations and digestive activity when cattle consuming low-protein native grass hay are given access to high-protein, free-choice block supplements.

Experimental Procedures

Four ruminally fistulated steers were housed at the Kansas State University Beef Cattle Research Center in individual (10 × 12 ft) stalls. Steers had free-choice access to prairie hay (Table 1), loose salt, and water. Two of the four steers also had free-choice access to SmartLic Hi-Pro 40 block supplements. Blocks were weighed daily to determine the amount of supplement consumed by each steer. Animals were allowed a 10-day period to adapt to their respective diets before samples of ruminal fluid were obtained.

In situ Cellulose Disappearance

This experiment was performed to quantify differences in capacity for digestion of cellulose in each animal over a period of 14 and 24 hours using an in situ procedure. Cellulose filter papers were weighed, placed into nylon bags, and sealed. The bags were then placed into the rumen of each steer for 14 or 24 hours. At the end of the fermentation period, bags were rinsed in warm water and then placed into a drying oven and allowed to dry overnight. The dried cellulose papers were removed from the bags and weighed, and the percentage of digestion was recorded for each.

Microscopic Imaging

We used a scanning electron microscope to compare bacterial colonization of cellulose filter papers that were suspended in the rumens of cattle fed diets with and without the SmartLic Hi-Pro 40 blocks. Cellulose filter papers were placed into sealed nylon bags and incubated in the rumen of each steer for 10 or 14 hours. After incubation, bags were removed from the rumen and rinsed with warm water. Filter papers were removed from the bags and rinsed with alcohol to remove residual moisture. Filter papers were taken to the scanning electron microscopy laboratory, where a very thin layer of gold was applied to the surface of the papers to improve resolution of the microscopic images. Microscopic images of each filter paper were photographed to provide a visual assessment of differences in bacterial colonization of cellulose.

[1] The authors express their sincere appreciation to Dr. T.G. Nagaraja, Kent Hampton, Cheryl Armendariz, and all personnel at the Beef Cattle Research Center who assisted in this study.

Measuring Activity of Cellulose-Digesting Ruminal Microbes

Our goal in this part of the experiment was to quantify changes in capacity for cellulose digestion in the ruminal fluid from cattle fed diets with and without the SmartLic Hi-Pro 40 block supplements. Ruminal fluid was collected from each steer and filtered through four layers of cheesecloth. Small aliquots of the ruminal fluid were added to oxygen-free culture tubes that contained thin strips of cellulose paper. Tubes were then placed into an incubator and allowed to incubate for 21 days. After incubation, the tubes were removed, and the extent of digestion of the cellulose paper was estimated to determine capacity for cellulose digestion.

Protozoa Counts

Populations of ruminal protozoa were determined for cattle fed diets with and without the SmartLic Hi-Pro 40 block supplements. Unfiltered ruminal fluid was obtained from each steer and transported to the laboratory. Contents were then mixed with formalin, diluted with a glycerol buffer, and dyed. To count protozoa, the solution was thoroughly homogenized, and precisely 1 mL was placed into a counting chamber slide. Slides were viewed under a microscope, and the numbers of protozoa were counted for 20 different locations on each slide.

Results and Discussion

Composition of the prairie hay fed to steers in this study is shown in Table 1. It is typical of prairie hay produced in the Flint Hills region (i.e., low in protein and high in neutral detergent fiber). Intakes of prairie hay and the SmartLic Hi-Pro 40 supplement by steers are shown in Table 2. Feeding the SmartLic Hi-Pro 40 blocks increased hay consumption by steers ($P<0.10$). These increases in hay intake are consistent with our observations in other experiments and likely are due to improvements in forage digestion achieved by providing nutrients essential to the rumen microbial population.

Figure 1 illustrates changes in cellulose disappearance in the rumen with and without supplementation of SmartLic Hi-Pro 40 blocks. Feeding SmartLic Hi-Pro 40 blocks substantially increased cellulose digestion, resulting in a 3-fold increase in cellulose degradation after 24 hours of ruminal incubation. Figure 2 shows several scanning electron microscope images. These images reveal major differences in the surface characteristics of cellulose paper before and after 14 hours of incubation in the rumen. Image 2A is cellulose before incubation in the rumen. Figures 2B and 2C are images of cellulose papers that were incubated in the unsupplemented animals, and images 2D and 2E are from steers that had access to SmartLic Hi-Pro 40 blocks. The microscopic images illustrate that supplementation influences bacterial colonization of cellulose, ultimately leading to more extensive digestion.

Counts of ruminal protozoa populations are shown in Table 3. As expected, supplementation with SmartLic Hi-Pro 40 blocks substantially increased the number of protozoa in the rumen. Large effects of supplementation ($P<0.05$) were observed in two major groups of protozoa—Dasytrich and Isotricha. Total numbers of protozoa also were greater in the supplemented animals.

Implications

Results of our experiments illustrate that supplementing forage-fed cattle with SmartLic Hi-Pro 40 blocks can enhance fiber digestion by affecting viability of the rumen microbial population. Ultimately, these improvements in digestion lead to increases in animal performance.

Table 1. Composition of prairie hay

Component	% of dry matter
Dry matter	94.49
Crude protein	5.71
Calcium	0.61
Phosphorus	0.06
Potassium	0.94
Neutral detergent fiber	63.57

Table 2. Consumption of prairie hay and SmartLic Hi-Pro 40 block supplements

Dry matter intake, lb	Unsupplemented	SmartLic Hi-Pro 40	SEM
Prairie hay[1]	12.8	18.0	1.22
SmartLic Hi-Pro 40 block	0	2.6	0.35

[1] Treatments are different, P<0.10.

Table 3. Numbers of ruminal protozoa from cattle fed prairie hay with and without SmartLic Hi-Pro 40 block supplements

Protozoa/mL ruminal fluid	Unsupplemented	SmartLic Hi-Pro 40	SEM
Isotricha	1,067	2,280	815
Dasytricha[1]	4,609	9,315	345
Entodinium[1]	22,269	33,621	1,580
Ostracodinium	6,210	5,094	1,032
Metadinium	242	242	174
Epidinium	5,045	5,773	1,271
Total protozoa[1]	38,328	57,444	2,128

[1] Treatments are different, P<0.05.

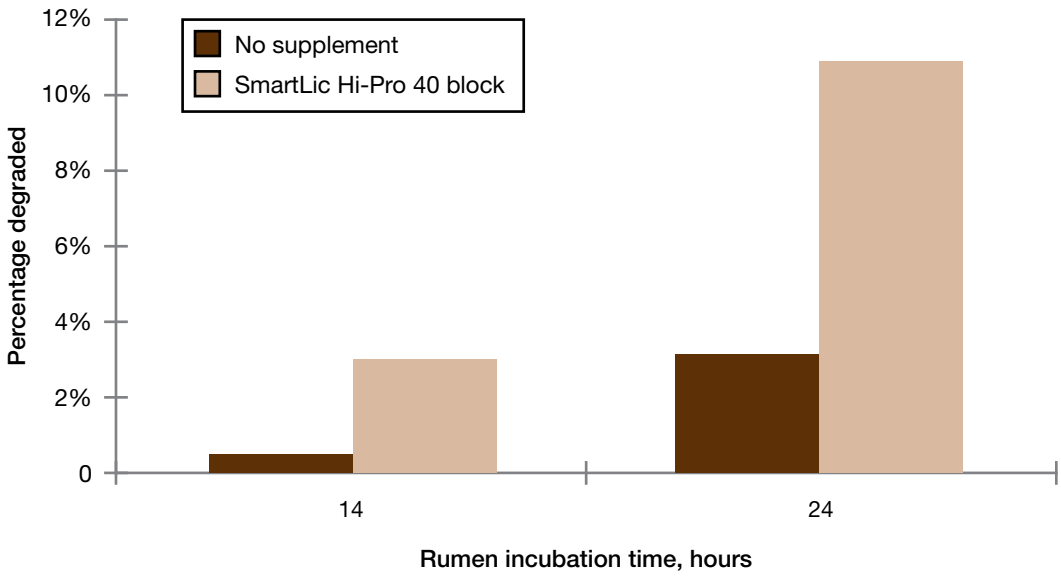

Figure 1. Disappearance of cellulose from nylon bags incubated in the rumens of steers fed prairie hay with and without SmartLic Hi-Pro 40 block supplements.

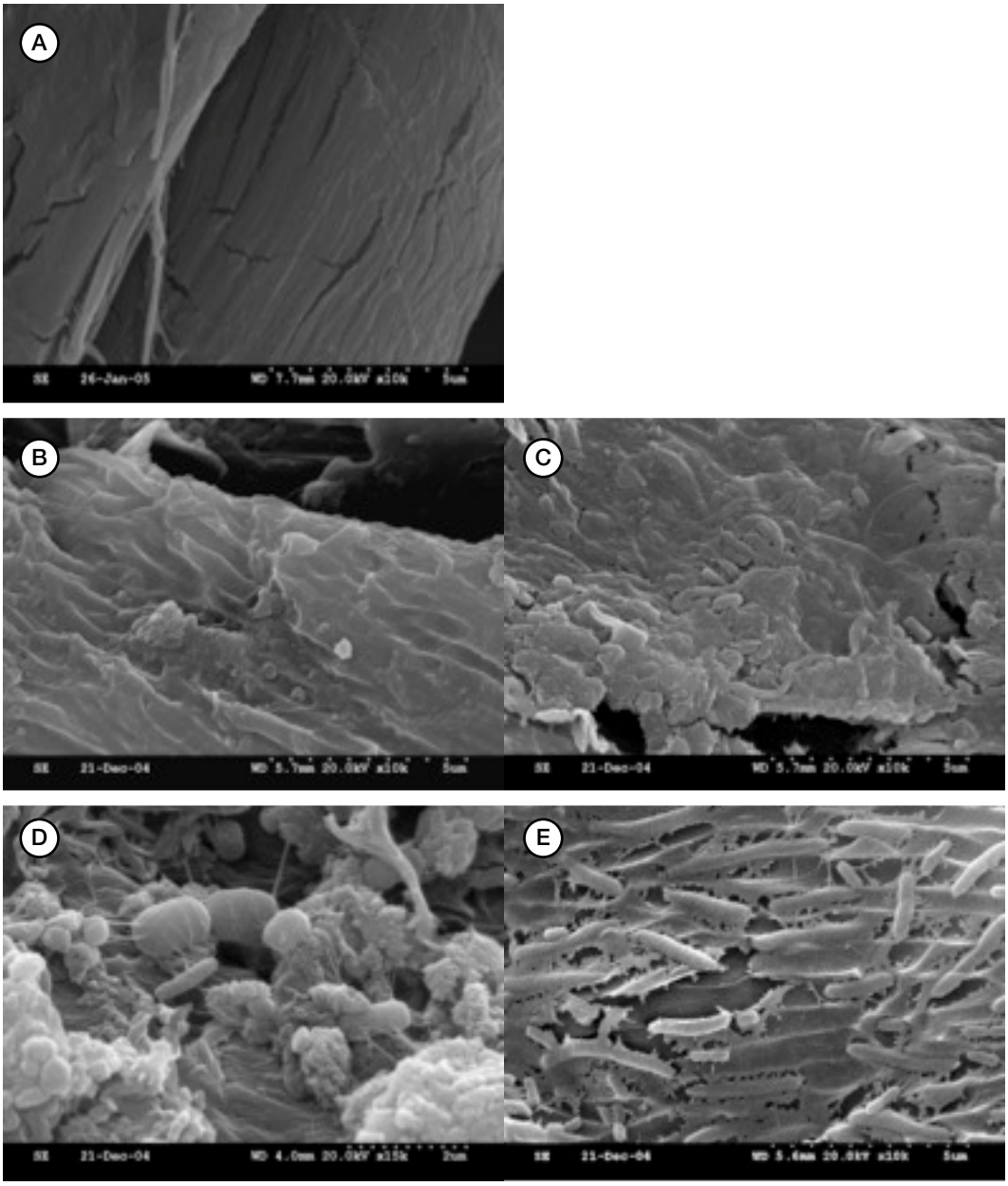

Figure 2. Scanning electron microscope images of cellulose before and after incubation in the rumens of steers fed prairie hay.
(A) cellulose paper before incubation in the rumen; (B and C) cellulose papers incubated for 14 hours in unsupplemented animals fed prairie hay; (D and E) images from animals fed prairie hay and supplemented with SmartLic Hi-Pro 40 blocks.