

BURNETT CENTER INTERNET PROGRESS REPORT

No. 2 - January, 1999

The Relationship Between Retrograde Starch as Measured by Starch Availability Estimates and In Vitro Dry Matter Disappearance of Steam-Flaked Corn

C. F. Ward and M. L. Galyean

Dept. of Anim. Sci. and Food Tech., Texas Tech University, Lubbock 79409-2141

Introduction

Starch availability estimates are frequently obtained on samples of steam-flaked corn and milo as a means of assessing degree of processing and monitoring quality and consistency of the flaking process. The typical method of assessing starch availability involves incubating a ground sample of flaked grain with amyloglucosidase enzyme and either measuring glucose release directly or via gas production by yeast (Duff et al., 1994). Samples for analysis are usually taken soon after flaking, most often either just as the flaked grain leaves the rolls or once it is conveyed to a storage bin. Starch in steam-flaked grains can undergo retrogradation, or reassociation of starch molecules that have been separated during gelatinization (Rooney and Pflugfelder, 1986). The potential effect of starch retrogradation, as measured by decreases in enzymatic starch availability, on digestibility of flaked grains and subsequent animal performance has not been well characterized.

In this report, we detail our evaluation of the in vitro dry matter disappearance (**IVDMD**) of samples from one lot of steam-flaked corn that differed in enzymatic starch availability, presumably as a result of starch retrogradation.

Experimental Procedures

Samples of steam-flaked corn used in this study were obtained at a commercial feedlot. Corn was steamed for approximately 45 min before rolling to a bulk density of 29 pounds per bushel through either 18-inch x 36-inch or 24-inch x 48-inch rolls. Grain moisture content before rolling was approximately 21 to 22%. Samples were taken at two different locations in the process and sent to a commercial laboratory for measurement of enzymatic starch availability (glucose release). The commercial laboratory normally provides this analytical service for the feedlot. **Roll** samples were taken with a shovel directly beneath the rolls, whereas flaked grain was conveyed to a storage bin by a drag chain and leg conveyor, and **Bin** samples were taken as flaked grain exited the storage bin. Time in the bin was not recorded. Both Roll and Bin samples were allowed to sit at room temperature for 10 to 15 min to allow the steam to evaporate (flash) before packaging and sending the samples to the commercial laboratory for analysis. The laboratory dried and ground the samples before analysis.

A composite of three Roll samples and a composite of six Bin samples were made available by the commercial laboratory for IVDMD analysis in the Texas Tech University Ruminant Nutrition Laboratory. The IVDMD procedure involved incubation of approximately .5 g of ground grain from

each of the two composite samples for 4, 8, 12, 18, 24, and 48 h at in a constant-temperature (39⁰C) water bath. Triplicate 50-mL centrifuge tubes were used for each incubation time for each sample, along with two “blank” cultures that did not contain substrate. Ruminant fluid had been obtained previously from four ruminally cannulated steers fed a high-concentrate diet, strained through cheesecloth, and frozen. Frozen ruminant fluid was thawed for approximately 6 h and then mixed (1 part ruminant fluid) with McDougall’s buffer (4 parts buffer) before being used as the inoculum. A 48-h incubation in acidified pepsin solution at 39⁰C followed the ruminant fluid-buffer incubation.

Results and Discussion

Enzymatic starch availability measured by the commercial laboratory averaged 55.3% (range 52 to 57%) for Roll samples and 33.3% (range 28 to 36%) for Bin samples (Table 1). Hence, the intent of the IVDMD procedure was to determine whether these differences in starch availability, presumably resulting from retrogradation of starch in Bin samples, would affect the ability of ruminant microbes to degrade starch.

The IVDMD data for various incubation times are shown in Table 1. We chose not to analyze these data statistically. This choice was made because we considered the triplicate incubation tubes per time/treatment combination to be analytical replicates rather than true experimental replicates. Nonetheless, these data should provide descriptive information as to the effects that varying enzymatic starch availability measurements had on IVDMD. No major differences in IVDMD were evident

between Roll and Bin samples, despite the much greater enzymatic availability of Roll samples. Virtually identical IVDMD measurements were noted for each incubation time, except for 8 h, at which time Bin samples had a numerically greater IVDMD than Roll samples. Taken collectively, these IVDMD data provide no evidence that the lower enzymatic starch availability observed with Bin vs Roll samples had any impact on the ability of ruminant microbes to degrade the DM, and presumably starch, in these samples.

Assuming that the lower enzymatic starch availability noted with Bin samples reflected retrogradation of starch, our results suggest that formation of retrograde starch in steam-flaked corn samples has little effect on degradation of starch by ruminant microbes. It also is possible that the differences in enzymatic starch availability between the Roll and Bin samples merely reflect a failure of the analytical method to release starch enzymatically for subsequent measurement. The method typically involves a relatively short (often 1 h) incubation of flaked grain with an enzyme:buffer solution. Given that formation of retrograde starch may increase the durability of steam-flaked grains (Rooney and Pflugfelder, 1986), a short incubation period with enzyme and buffer may be inadequate to fully wet the sample and allow for necessary enzyme activity.

Summary and Conclusions

Our data suggest that differences in enzymatic starch availability resulting from when and where samples were taken after steam flaking had no effect on the degradation of steam-flaked corn dry matter in an in vitro culture system. Hence, these results suggest that such differences in

enzymatic starch availability would be unlikely to affect animal performance. Perhaps the most important conclusion that can be drawn from our results is that when enzymatic starch availability is used to monitor the quality and consistency of the steam-flaking process, care should be taken to obtain samples for analysis in a consistent manner over time.

Literature Cited

- Duff, G. C., M. L. Galyean, J. Rakestraw, D. Cross, and S. L. Armbruster. 1994. Starch availability estimates from two commercial laboratories using steam-flaked corn and steam-flaked milo. Clayton Livestock Res. Center Prog. Rep. No. 94.
- Rooney, L. W., and R. L. Pflugfelder. 1986. Factors affecting starch digestibility with special emphasis on sorghum and corn. *J. Anim. Sci.* 63:1607-1623.

Acknowledgements

This research was supported by funds from the Thornton Endowment, Texas Tech University. The authors thank Dr. S. E. Bachman and Steve Armbruster Consulting, Inc. for provision of samples, laboratory starch availability data, and general assistance with the research.

Table 1. Enzymatic starch availability and in vitro dry matter disappearance (IVDMD) of steam-flaked corn samples obtained directly off the rolls (Roll) or after being conveyed to a storage bin (Bin)

Item	Roll samples ^a	Bin samples ^b
Starch availability, %	55.3	33.3
IVDMD, %		
4-h	21.79	20.32
8-h	27.66	34.51
12-h	43.16	45.98
18-h	67.58	68.47
24-h	84.01	84.35
48-h	93.09	96.81

^aComposite of three samples.

^bComposite of six samples.