

ROCK RIVER LABORATORY, INC. AGRICULTURAL ANALYSIS

INTRODUCTION:

- •Ground, dry shelled corn or corn grains produced by feed mills is not uniform in particle size characteristics nor consistent relative to animal performance
- •Ground, dry corn grain geometric mean particle size (GMPS; Firkins et al., 2001; Ferraretto et al., 2013) has been related to ruminal and total tract starch digestion by dairy cattle
- The standard deviation around the mean is also generally thought impact to dairy cattle digestion and performance
- •GMPS (micron) has been related to rumen digestion (Firkins et al., 2001) but little research has been completed evaluating commercially ground corn or corn grains of less than 700 micron GMPS
- •Some feed mills are now capable of routinely grinding dry corn to yield GMPS of less than 400 microns
- •Reduced particle size to below 806 micron has been shown to offer an advantage in peak absolute gas production rate (PAR), with the relationship between GMPS and PAR being non-linear (Hoffman et al., 2011)
- •GMPS and standard deviation can be combined into a surface area (SA) measure for practical considerations using mathematic equations (SA, cm²; ASABE, 2008)
- Surface area is exponentially related to GMPS and has been discussed in relation to cattle digestion and performance but not directly related to fermentation potential (Hoffman et al., 2011)

OBJECTIVE:

The objective of our work was to determine if GMPS or SA were better in relating to rumen in situ starch disappearance (isSD, % starch) for commercially ground, dry shelled corns

MATERIALS AND METHODS:

- together
- weight retained on each sieve
- •GMPS and SA were determined according to ASABE (2008)

RUMEN *IN SITU* DIGESTION TECHNIQUE

- •Original, intact corn samples were weighed, 3g, into Ankom R510 bags (50µm pores) for in situ rumen incubation
- •Bags were soaked in warm water and incubated for 0h as a single replicate or for 7h in triplicate across three ruminally-cannulated lactating dairy cows consuming a high-forage diet
- for three, five-minute cycles
- •Rinsed bags were then dried at 50C in a forced air oven for 24h and weighed to determine the DM disappearance •DM disappearance was determined as DM lost during incubation
- Residues were composited and starch assessed
- •Corn grain starch disappearance at 0h (SD0) and 7h (isSD7) were determined as
- starch loss during incubation

STATISTICAL ANALYSIS

- •Data were analyzed as a randomized complete block using the Fit Model function within SAS JMPv11.0 (Cary, NC)
- •Time point (class variable), starch, and GMPS or SA were related to isSD using backward elimination
 - •GMPS and SA were not allowed within the same final model due to GMPS being exponentially related to SA

 - •SA was determined using the following equation (ASABE, 2008):
 - = 6 /1 .32*EXP(0.5*LN(Standard Deviation)^2-LN(GMPS*0.0001)) •Linear and quadratic effects were evaluated in relation to starch
 - disappearance
- hence only SA remained within the final model
- •Residual plots were assessed for normality

COMMERCIAL GROUND CORN SURFACE AREA IS BETTER RELATED TO RUMEN **DISAPPEARANCE THAN GEOMETRIC MEAN PARTICLE SIZE**

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•Commercial ground, dry shelled corn (n=38) samples were collected from feed mills throughout the Eastern (n=19) and Midwestern US (n=19)

•Samples were collected over a several month period and assessed at one time,

•Corn samples were assessed for starch (% DM) according to Hall (2008) AOAC procedure. Samples were assessed for particle size characteristics by shaking eight sieves using a RoTap particle separator for 10 min. and determining percent

•Sieves included: 2000, 1000, 840, 500, 250, 149 and 105 micron sizes and the

•Post incubation, the dacron bags were rinsed in a commercial laundry machine

•The SA sum of squares was nearly three times that of GMPS (908 vs 328),

Table I: Commercial ground corn measure population descriptive statistics.			
PARAMETER	MEAN	STANDARD DEVIATION	COEFFICIENT OF VARIATION
Starch, % of DM	70.6	3.2	4.53
GMPS, micron	715	233	32.59
Surface area, cm²/g	92.7	20.8	22.44
in situ starchD, 0h, % of starch	19.8	12.4	62.63
in situ starchD, 7h, % of starch	68.7	10.6	15.43

RESULTS AND DISCUSSION:

- •Commercial ground corn samples appeared to vary substantially •The coefficients of variation ranged from 4.5 to 62.6, depending on parameter of interest (Table 1)
- •Raw starch disappearance means are presented in Figure 1 •Following final statistical model fit, the model exhibited an adjusted $R^2 = 0.86$ and standard error of 10.3
 - •Time, starch, and surface area were linearly (P<0.02) related to starch disappearance
 - •Starch content was positively related to in situ rumen disappearance. •This could be explained by a lesser endosperm hydrophobic protein
 - (prolamin) content in greater starch content grains
 - •Greater starch could correspond to lesser protein and less prolamin
 - content however this warrants further analysis
 - 2011)
- •Time and starch content showed a trend towards an interaction (P<0.06) •0h tended to increase in SD with increased starch to a greater extent than 7h
- •The parameter estimate for surface area in relation to is SD was 0.20 with a standard error (SE) of 0.06
 - •This result could be interpreted to mean that for each 10 unit gain in SA (cm^2/g), rumen starch disappearance could be expected to increase by 2% of starch •SA by starch disappearance results, separated for 0h or 7h measures, are
 - presented in Figure 2

CONCLUSIONS:

disappearance than geometric mean particle size evaluating ground corn and quality control •The top 15% SA evaluated here were >110 cm2/g

•Prolamin content has been related to fermentation potential (Hoffman et al.,

- •These observations suggest surface area is better related to rumen starch
- •Surface area results should also be considered by commercial feed mills when

Figure I: Raw starch disappearance means plotted against incubation

Figure 2: Commercial ground corn in situ starch disappearance, 0h or 7h in rumen, plotted against surface area.

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