Effect of corn silage kernel processing score on dairy cow starch digestibility

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Introduction

- In the USA, dairy producers and nutritionists have put more focus on feed efficiency of milk production.
- Low on-farm starch digestibility contributes to reduced feed efficiency.
- Ferraretto and Shaver (2012) and Ferguson (2003) demonstrated fecal starch is highly negatively correlated to total tract starch digestibility in dairy cows.
- One factor affecting the digestibility of starch in high producing lactating dairy cows is the extent of the processing of the corn kernel during the harvesting of corn silage.
- Kernel processors are employed on the forage harvesters to break the corn kernel into smaller fractions.
- Management of the kernel processing equipment, kernel maturity, and hardness of the corn (flint vs. vitreous) affects extent kernel processing.
Kernel Processing correlates to availability of starch to rumen and intestinal digestion.

Fecal starch is used to measure total tract starch digestion in dairy cows.

Research (Ferguson, 2003) demonstrated that each 1% decrease in fecal starch results in 0.33 kg more milk.

At milk price of $0.35/kg, 4% decrease in fecal starch equivalent to $0.46/more revenue per cow/day.

1,000 cows = $460 per day more revenue

That’s Real Money!
A kernel processing score (KPS) was developed by Mertens (2005)

- Involves submitting a corn silage sample to a laboratory where it is dried and sifted through variable sized mesh sieves.
- A starch analysis is performed and the portion of the starch that passes through a 4.75 millimetre sieve is determined more digestible by the lactating dairy cow.

<table>
<thead>
<tr>
<th>Percent of starch less than 4.75 mm</th>
<th>Kernel Processing Score (KPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 70</td>
<td>Optimum</td>
</tr>
<tr>
<td>50 to 70</td>
<td>Adequate</td>
</tr>
<tr>
<td>Less than 50</td>
<td>Poor</td>
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</tbody>
</table>
### Differences in Kernel Processing Score (KPS)

<table>
<thead>
<tr>
<th>Date</th>
<th>%Moist</th>
<th>%DM</th>
<th>%KPS</th>
<th>%Starch</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/22</td>
<td>62.6</td>
<td>37.4</td>
<td>58.9</td>
<td>30.5</td>
</tr>
<tr>
<td>10/28</td>
<td>60.7</td>
<td>39.3</td>
<td>72.4</td>
<td>30.9</td>
</tr>
</tbody>
</table>

High KPS appears to be low starch samples “Usually not the case”
At 25 kg dry matter intake, 28% TMR starch = energy to produce 4.3 kg 3.5% FCM milk = $1.50 more revenue/cow/day
Objective

This trial determined the effect of extent of kernel processing of corn silage on fecal starch and total tract starch digestibility (TTSD) on large commercial dairy farms.
Materials and Methods

- Data from December, 2012 to July, 2013
- 35 dairy operations ranging in size from approximately 1,200 to 6,800 cows
- Represented approximately 58,000 cows located in the states of Wisconsin, Iowa, Minnesota, Illinois, and S. Dakota
- A minimum of at least 6 core samples from the face of corn silage bunkers or drive-over piles was consolidated
- A sub-sample sent to a commercial lab (Rock River Laboratories, Watertown, Wisconsin) for KPS determination using the method of Mertens (2005).
- On the same farms and same day, fresh floor fecal samples were collected from at least 20 cows per pen from pens with cows less than 120 days-in-milk
- Composite fecal sample analysed for FS by Rock River Laboratories (Watertown, WI)
- Measured the content of starch in the feces of cows fed the corresponding corn silage
- Some dairies were sampled more than once as they changed sources of corn silage
Marking bunker face to indicate location of borings

Tennis balls indicate boring locations

Co-Author
Drilling core sample
Results- Fecal starch % plotted against respective silage kernel processing score (%) for each dairy sample (n=47)
Regression Analysis

Prediction equation: $y = 12.90487 \pm 1.04 - 0.15065x \pm 0.019$

$y =$ fecal starch, %  $x =$ kernel processing score, %

$P < 0.001$

$R^2 = 0.58$
Results and Discussion

- A negative relationship between KPS % and FS % was observed \( R^2=0.58, \, P<0.001 \)
- Ferraretto and Shaver (2012) demonstrated a negative relationship between FS and total tract starch digestibility \( (R^2 = 0.94) \).
- Because of poor kernel processing, this excess of starch in manure decreases feed efficiency of milk production, adds to the manure load on a dairy farm, and represents wasted money on feed that is not digested.
Conclusions

- Wide variation in KPS (34-76%) on the Midwest USA farms that participated in this research.
- High negative correlation between corn KPS and FS in high producing lactating dairy cows.
- Only 4 out of 47 (9%) FS % were below 1.5% suggesting a need to focus on improving kernel processing greater than current standard of 70% KPS.

- Optimum KPS % should be minimum 80% to achieve 1.0% FS and optimizing total tract starch digestibility in dairy cows.
Conclusions

- Applying the regression suggests that 86% KPS is maximum to intersect at 0% FS

- Improving corn kernel processing during corn forage harvest is a management tool that can increase:
  - Total tract starch digestibility
  - Milk production efficiency
  - Increase sustainability of dairy production
  - 80% KPS should be considered optimum standard
Thank You for Your Attention

Questions?

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Corn Silage Kernel Processing Score (KPS) Guidelines and Benchmarks

Rock River Lab Data summarized by Dr. John Goeser

% Corn Silage Starch that Passes through a 4.75mm Screen

Industry Guidelines

<table>
<thead>
<tr>
<th>Industry Guidelines</th>
<th>Rock River Lab % of Samples in Each Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimum</td>
<td>&gt;70%</td>
</tr>
<tr>
<td>Average</td>
<td>50 to 70%</td>
</tr>
<tr>
<td>Below Average</td>
<td>&lt;50%</td>
</tr>
<tr>
<td></td>
<td>16.4%</td>
</tr>
<tr>
<td></td>
<td>62.1%</td>
</tr>
<tr>
<td></td>
<td>21.5%</td>
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</table>

Rock River Lab Results

<table>
<thead>
<tr>
<th>All Years</th>
<th></th>
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<tbody>
<tr>
<td>Mean</td>
<td>59.0%</td>
</tr>
<tr>
<td>Realistic Min</td>
<td>38.8%</td>
</tr>
<tr>
<td>Realistic Max</td>
<td>80.0%</td>
</tr>
</tbody>
</table>
With the increased cost of grain and forages in the USA, dairy producers have turned their attention to the feed efficiency of milk production. Low on-farm starch digestibility contributes to reduced feed efficiency. Several researchers have demonstrated that measuring fecal starch (FS) is highly correlated to total tract starch digestibility in dairy cows. One factor affecting the digestibility of starch in lactating dairy cows is the extent of the processing of the corn kernel during the harvesting of corn silage. Kernel processors are employed on the forage harvesters to break the corn kernel into smaller fractions. The extent of kernel processing varies based upon the management of the kernel processing equipment, kernel maturity, hardness of the corn, and extent of corn silage fermentation. A kernel processing score (KPS) was developed by Mertens (2005) which involves submitting a corn silage sample to a laboratory where it is dried and sifted through variable sized mesh sieves. A starch analysis is performed and the portion of the starch that passes through a 4.75 millimetre sieve is determined more digestible by the lactating dairy cow. Guidelines for KPS are >70%, excellent; 50 to 70 adequate; and <50% poor.

This trial determined the effect of extent of kernel processing of corn silage on fecal starch and total tract starch digestibility (TTSD) on large commercial dairy farms.

Materials and Methods

- Composite sample analysed for FS by Rock River Laboratories (Watertown, WI)
- Measured the content of starch in the feces of cows fed the corresponding corn silage
- Some dairies were sampled more than once as they changed sources of corn silage

Results and Discussion

- A negative relationship between % KPS and FS % (Figure 1) was observed.
- Figure 2 plots the KPS score compared to the respective FS % (DM basis) of each dairy arranged from high to low KPS. Linear lines were plotted for both KPS and fecal starch %.
- Ferraretto and Shaver (2012) and Ferguson (2003) both demonstrated a negative relationship between FS and total tract starch digestibility ($R^2 = 0.94$).
- Ferguson (2003) estimated that for each one percentage unit increase in FS above 5% (DM basis), a corresponding decrease of 0.35 kg of milk yield per cow per day can be expected.
- This excess of starch in manure decreases feed efficiency of milk production, adds to the manure load on a dairy farm, and represents wasted money on feed that is not digested.

Conclusions

- A wide variation in kernel processing scores (34-76%) on the Midwest USA farms that participated in this research.
- Only 4 out of 47 (9%) fecal starch % was below 1.5% suggesting a need to focus on improving kernel processing greater than 70% KPS.
- High negative correlation between corn kernel processing score and fecal starch in high producing lactating dairy cows.
- Improving corn kernel processing during corn forage harvest is a management tool that can increase total tract starch digestibility and increase milk production efficiency.