NUTRIDENSE® CORN GRAIN AND CORN SILAGE FOR DAIRY COWS
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TAKE HOME MESSAGES

- The concentration of crude protein, neutral detergent fiber, acid detergent fiber, and ether extract in NutriDense corn grain and NutriDense “leafy” corn silage were higher and nonfibrous carbohydrates and starch concentrations were lower than that in the control yellow dent corn grain and silage.

- There were no significant differences in production and composition of milk or in efficiency of feed utilization by dairy cows fed the NutriDense and control yellow dent corn hybrids in this trial.

INTRODUCTION
Corn hybrids of enhanced nutritional quality for livestock are emerging in the marketplace. These hybrids are the result of breeding programs that focus on improving nutrient content, profile, and digestibility, or a combination of these factors supplied by grain or the whole plant preserved as silage. Examples of outcomes from such breeding programs are the corn hybrids NutriDense (ND) and leafy NutriDense (LND). The ND hybrid was developed through conventional breeding to produce kernels with a larger embryo (germ) and, consequently, higher contents of oil, protein, and some essential amino acids (Lys, Met, Cys, Thr, and Trp) than conventional yellow dent (YD) corn hybrids. Recently the LND hybrid also was bred to produce grain with a nutrient content that was greater than that for YD but also to contain more leaves above the ear than ND. These traits were combined in LND with the goal of increasing the concentration and digestibility of nutrients supplied to dairy cows from whole-plant corn silage. The objectives of this study were to compare the effects of whole-plant silage and grain produced from LND, ND, and YD on rumen fermentation, nutrient digestibility, and performance of lactating dairy cows.

MATERIALS AND METHODS
Three corn hybrids were used in the study: 1) a YD hybrid [BASF Plant Science (BPS) EX 6485] used to produce grain and whole-plant silage (control), 2) LND (BPS EX 6275) used to prepare whole-plant silage, and 3) ND (BPS EX 6413) to produce grain. Twenty multiparous Holstein cows (4 surgically fitted with ruminal cannulas) were randomly assigned to four dietary treatments in each of five Latin squares. Dietary treatments were: 1) YD grain and silage (YDG + YDS), 2) YD grain and LND silage (YDG + LND), 3) ND grain and YD silage (NDG + YDS), and 4) ND grain and LND silage (NDG + LND). On a dry matter basis, diets contained 19.65%...
alfalfa silage, 30.56% corn silage, 27.65% ground shelled corn, 9.17% soybean meal (48% crude protein), 10.04% soybean hulls, and 2.94% mineral and vitamin mix.

Diets were fed as total mixed rations twice daily to ensure 5 to 10% orts. Cows were milked twice daily and ruminal fermentation and total tract digestibility measurements were made using the four ruminally cannulated cows. Experimental periods were 28 days in length. The first 14 days were used to adjust cows to diets and the last 14 days were used to collect data. Data were statistically analyzed using the MIXED procedure of SAS (2000).

RESULTS AND DISCUSSION

The ND corn silage and grain contained more crude protein, neutral detergent fiber, acid detergent fiber, and ether extract than the control YD corn silage and grain but contained less starch and nonfibrous carbohydrates (Table 1). Because the diets were formulated to contain the same proportions of feed ingredients, their chemical composition reflected the above mentioned differences between sources of corn grain and silage (Table 2). With the exception of neutral detergent fiber, the percentages of crude protein, acid detergent fiber, ether extract, and net energy lactation were highest for the NDG + LNG treatment, intermediate for the YDG + LNG and NDG + YDS diets, and lowest for the YDG + YDS treatment. The percentages of nonfibrous carbohydrates and starch followed the opposite trend.

Dry matter intake and net energy lactation intakes were similar for all diets; however, there were significant differences among diets for intakes of crude protein, neutral detergent fiber, acid detergent fiber, nonfibrous carbohydrates, starch, and ether extract (Table 3). Diets containing ND corn as grain or “leafy” silage decreased nonfibrous carbohydrates and starch intakes but increased intakes of ether extract and crude protein. Diets containing ND “leafy” corn silage increased neutral detergent fiber and acid detergent fiber intakes but had no effect on intakes of dry matter or net energy lactation.

Ruminal pH, concentration of total volatile fatty acids, molar rations of volatile fatty acids, and concentrations of ammonia nitrogen were not different among diets (data not shown). With the exception of starch and ether extract, there were no differences in digestibility of diets (Table 4). Treatment YDG + LND resulted in higher starch digestibility than that of the other three diets. Digestibility of ether extract was lowest for the YDG + YDS diet.

Production of milk and 3.5% FCM; efficiency of feed utilization; milk fat, crude protein, true protein, lactose, and total solids percentage and yield; body weight change; and body condition score were not affected by treatments (Table 5). Milk urea nitrogen was greater for diets containing ND corn grain than for diets containing the control YD corn grain but that might be because of higher crude protein intakes and lower starch intakes for the NDG + YDS and NDG + LND diets.
Table 1. Chemical composition of grains and silages.

<table>
<thead>
<tr>
<th>Item</th>
<th>YDS (YDS)</th>
<th>LND (LND)</th>
<th>YDG (YDG)</th>
<th>NDG (NDG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>40.4</td>
<td>36.4</td>
<td>89.4</td>
<td>88.5</td>
</tr>
<tr>
<td>Crude protein</td>
<td>7.7</td>
<td>8.5</td>
<td>7.7</td>
<td>10.7</td>
</tr>
<tr>
<td>Neutral detergent fiber</td>
<td>41.0</td>
<td>46.5</td>
<td>7.9</td>
<td>11.1</td>
</tr>
<tr>
<td>Acid detergent fiber</td>
<td>22.2</td>
<td>25.3</td>
<td>2.2</td>
<td>4.5</td>
</tr>
<tr>
<td>Nonfibrous carbohydrates(^2)</td>
<td>42.1</td>
<td>35.5</td>
<td>78.7</td>
<td>72.1</td>
</tr>
<tr>
<td>Starch</td>
<td>35.7</td>
<td>24.2</td>
<td>68.6</td>
<td>58.2</td>
</tr>
<tr>
<td>Ether extract</td>
<td>4.0</td>
<td>5.0</td>
<td>4.9</td>
<td>6.4</td>
</tr>
</tbody>
</table>

\(^1\)LND = Leafy NutriDense corn silage; NDG = NutriDense corn grain; YDG = yellow dent corn grain; YDS = yellow dent corn silage.

\(^2\)Nonfibrous carbohydrates = 100 – (% NDF + % CP + % ether extract + % ash).

Table 2. Chemical composition of the experimental diets (dry matter basis).

<table>
<thead>
<tr>
<th>Item</th>
<th>YDG + YDS</th>
<th>YDG + LND</th>
<th>NDG + YDS</th>
<th>NDG + LND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter, %</td>
<td>55.5</td>
<td>52.8</td>
<td>55.4</td>
<td>52.9</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>14.7</td>
<td>14.9</td>
<td>15.7</td>
<td>16.0</td>
</tr>
<tr>
<td>Neutral detergent fiber, %</td>
<td>32.7</td>
<td>34.4</td>
<td>32.6</td>
<td>34.3</td>
</tr>
<tr>
<td>Acid detergent fiber, %</td>
<td>19.3</td>
<td>20.2</td>
<td>19.5</td>
<td>20.5</td>
</tr>
<tr>
<td>Nonfibrous carbohydrates, %</td>
<td>43.9</td>
<td>41.9</td>
<td>42.1</td>
<td>40.1</td>
</tr>
<tr>
<td>Starch, %</td>
<td>29.0</td>
<td>25.4</td>
<td>27.2</td>
<td>23.7</td>
</tr>
<tr>
<td>Ether extract, %</td>
<td>3.6</td>
<td>3.9</td>
<td>4.1</td>
<td>4.4</td>
</tr>
<tr>
<td>Net energy lactation,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mcal/lb dry matter</td>
<td>.704</td>
<td>.708</td>
<td>.713</td>
<td>.717</td>
</tr>
</tbody>
</table>

\(^1\)LND = Leafy NutriDense corn silage; NDG = NutriDense corn grain; YDG = yellow dent corn grain; YDS = yellow dent corn silage.

Table 3. Least squares means for intakes of dry matter, crude protein, carbohydrates, ether extract, and net energy lactation by lactating dairy cows.

<table>
<thead>
<tr>
<th>Item</th>
<th>YDG + YDS</th>
<th>YDG + LND</th>
<th>NDG + YDS</th>
<th>NDG + LND</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter, lb/day</td>
<td>59.5</td>
<td>59.3</td>
<td>58.8</td>
<td>59.9</td>
<td>0.70</td>
</tr>
<tr>
<td>Crude protein, lb/day</td>
<td>8.7(^b)</td>
<td>8.8(^b)</td>
<td>9.3(^a)</td>
<td>9.6(^a)</td>
<td>0.01</td>
</tr>
<tr>
<td>Acid detergent fiber, lb/day</td>
<td>11.5(^b)</td>
<td>11.9(^a)</td>
<td>11.5(^b)</td>
<td>12.3(^a)</td>
<td>0.01</td>
</tr>
<tr>
<td>Neutral detergent fiber, lb/day</td>
<td>19.4(^b)</td>
<td>20.3(^a)</td>
<td>19.2(^b)</td>
<td>20.5(^a)</td>
<td>0.01</td>
</tr>
<tr>
<td>Nonfibrous carbohydrates, lb/day</td>
<td>26.2(^a)</td>
<td>24.9(^b)</td>
<td>24.9(^b)</td>
<td>24.0(^c)</td>
<td>0.01</td>
</tr>
<tr>
<td>Starch, lb/day</td>
<td>17.2(^a)</td>
<td>15.6(^b)</td>
<td>16.1(^b)</td>
<td>14.5(^c)</td>
<td>0.01</td>
</tr>
<tr>
<td>Ether extract, lb/day</td>
<td>2.1(^d)</td>
<td>2.3(^e)</td>
<td>2.4(^b)</td>
<td>2.6(^a)</td>
<td>0.01</td>
</tr>
<tr>
<td>NE(_L), Mcal/day</td>
<td>41.9</td>
<td>42.0</td>
<td>42.0</td>
<td>43.0</td>
<td>0.36</td>
</tr>
</tbody>
</table>

\(^1\)LND = Leafy NutriDense corn silage; NDG = NutriDense corn grain; YDG = yellow dent corn grain; YDS = yellow dent corn silage.

\(^a,b,c,d\)Values within the same row with uncommon superscripts are different (P<0.05).
Table 4. Least squares means for dry matter intake and digestibility of dry matter, crude protein, carbohydrates, and ether extract by the ruminal cannulated dairy cows.

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialysis</td>
<td>YDG + YDS</td>
</tr>
<tr>
<td>Dry matter, lb/day</td>
<td>60.8</td>
</tr>
<tr>
<td>Digestibility</td>
<td></td>
</tr>
<tr>
<td>Dry matter</td>
<td></td>
</tr>
<tr>
<td>lb/day</td>
<td>41.0</td>
</tr>
<tr>
<td>%</td>
<td>67.9</td>
</tr>
<tr>
<td>Crude protein</td>
<td></td>
</tr>
<tr>
<td>lb/day</td>
<td>5.5</td>
</tr>
<tr>
<td>%</td>
<td>61.0</td>
</tr>
<tr>
<td>Acid detergent fiber</td>
<td></td>
</tr>
<tr>
<td>lb/day</td>
<td>5.5</td>
</tr>
<tr>
<td>%</td>
<td>48.8</td>
</tr>
<tr>
<td>Neutral detergent fiber</td>
<td></td>
</tr>
<tr>
<td>lb/day</td>
<td>11.7</td>
</tr>
<tr>
<td>%</td>
<td>56.4</td>
</tr>
<tr>
<td>Starch</td>
<td></td>
</tr>
<tr>
<td>lb/day</td>
<td>13.7ᵇ</td>
</tr>
<tr>
<td>%</td>
<td>87.5ᵇ</td>
</tr>
<tr>
<td>Ether extract</td>
<td></td>
</tr>
<tr>
<td>lb/day</td>
<td>1.2ᵇ</td>
</tr>
<tr>
<td>%</td>
<td>65.2</td>
</tr>
</tbody>
</table>

¹LND = Leafy NutriDense corn silage; NDG = NutriDense corn grain; YDG = yellow dent corn grain; YDS = yellow dent corn silage.

ᵃᵇValues within the same row with uncommon superscripts are different (P<0.05).
Table 5. Least squares means for milk production, milk composition, bodyweight change, and body condition score.

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
<th>YDG + YDS</th>
<th>YDG + LND</th>
<th>NDG + YDS</th>
<th>NDG + LND</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk, lb/day</td>
<td></td>
<td>80.8</td>
<td>80.4</td>
<td>79.3</td>
<td>80.8</td>
</tr>
<tr>
<td>3.5% FCM, lb/day</td>
<td></td>
<td>83.3</td>
<td>83.0</td>
<td>81.1</td>
<td>83.5</td>
</tr>
<tr>
<td>FCM/dry matter intake</td>
<td></td>
<td>1.40</td>
<td>1.41</td>
<td>1.38</td>
<td>1.40</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td>3.72</td>
<td>3.71</td>
<td>3.68</td>
<td>3.72</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td>2.97</td>
<td>2.97</td>
<td>2.89</td>
<td>3.00</td>
</tr>
<tr>
<td>lb/day</td>
<td></td>
<td>3.31</td>
<td>3.32</td>
<td>3.30</td>
<td>3.34</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td>2.67</td>
<td>2.67</td>
<td>2.60</td>
<td>2.69</td>
</tr>
<tr>
<td>Crude protein</td>
<td></td>
<td>3.12</td>
<td>3.13</td>
<td>3.13</td>
<td>3.15</td>
</tr>
<tr>
<td>lb/day</td>
<td></td>
<td>2.49</td>
<td>2.51</td>
<td>2.47</td>
<td>2.53</td>
</tr>
<tr>
<td>MUN, mg/dL</td>
<td></td>
<td>11.13b</td>
<td>11.09b</td>
<td>12.13a</td>
<td>12.04a</td>
</tr>
<tr>
<td>Lactose</td>
<td></td>
<td>4.79</td>
<td>4.80</td>
<td>4.81</td>
<td>4.84</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td>3.88</td>
<td>3.85</td>
<td>3.81</td>
<td>3.92</td>
</tr>
<tr>
<td>Total solids</td>
<td></td>
<td>12.56</td>
<td>12.57</td>
<td>12.53</td>
<td>12.64</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td>10.09</td>
<td>10.09</td>
<td>9.89</td>
<td>10.18</td>
</tr>
<tr>
<td>Body weight change, lb/day</td>
<td></td>
<td>-1.0</td>
<td>-1.2</td>
<td>-0.6</td>
<td>-1.2</td>
</tr>
<tr>
<td>Body condition score2</td>
<td></td>
<td>2.81</td>
<td>2.93</td>
<td>2.86</td>
<td>2.82</td>
</tr>
</tbody>
</table>

1LND = Leafy NutriDense corn silage; NDG = NutriDense corn grain; YDG = yellow dent corn grain; YDS = yellow dent corn silage.

2Scale of 1 to 5 in quarter-point increments where 1 = thin to 5 = fat.

abValues within the same row with uncommon superscripts are different (P<0.05).