A Nutritional Evaluation of Mixed Winter Cereals with Vetch Utilized as Silage or Hay

E. J. DePETERS, J. F. MEDRANO, and D. L. BATH
Department of Animal Science
University of California
Davis 95616

ABSTRACT

Cereal-vetch silage replaced chopped alfalfa in the forage portion of diets fed to lactating cows, resulting in diets containing 100, 66, and 34% of the forage as chopped hay. Winter cereal (oat, wheat, and barley) and vetch mixture was harvested when the oats were at the bloom stage, field wilted, and ensiled. Total DM intake of cows during the first 15 wk of lactation was reduced at the highest amount of cereal silage inclusion. Gut fill may have restricted DM intake since NDF intakes were similar across diets. Yields of milk and 4% FCM were not different with cereal-vetch silage addition to the diet. Milk composition of fat and solids were not altered by diet, but protein was lowest on the high silage diet.

Cereal-vetch forage was harvested as hay at four stages of maturity based on maturity of oats: bloom, milk, soft dough, and hard dough. As forage matured, content of CP, ADF, and NDF and in vitro DM digestibility decreased and lignin content increased. Hays were pelleted and fed to 16 wethers in a total collection digestion study. Digestibilities of DM, energy, and fiber were similar for bloom and milk stages but decreased as maturity progressed to the hard dough stage.

INTRODUCTION

Use of winter cereals as a forage in the rations of lactating dairy cows in California is increasing. These winter cereals include barley, wheat, and oats, either alone or as mixtures. Sometimes vetches or peas are included in the cereal mixtures to enhance the protein content of the forage mix. Information in the literature is lacking on the nutritive value of cereal forages in the ration of high producing dairy cows.

The increased popularity of cereals is the forage program is related to emphasis on reducing cost of production and maximizing output of cows and land. In many areas of California, cereals fit well into a double cropping program where the cereals are planted in the fall and harvested for silage in the spring followed by corn. Most cereals are harvested in the soft dough stage of maturity, but performance of dairy cows often is low when cereal silages are fed.

Maturity has important effects on the quality of cereal forage. Small grain forages consisting of wheat, oats, triticale, or barley were grown and harvested at six stages of maturity (3). Crude protein content for all species decreased with increasing maturity. Concentration of ADF and cell wall constituents (CWC) increased as the forage advanced in maturity from flag leaf until 7 d after inflorescence. Thereafter, these constituents reached a plateau. This plateau of fiber content (%) may be related to the fact that the grain head accounts for a greater proportion of the plant DM accompanied by some decrease in both leaf and stem components (14). Acid detergent lignin (ADL), in contrast to CWC and ADF, increased consistently with advancing maturity (3). In vitro DM digestibility (IVDMD) declined with maturation and was negatively correlated with ADL content of the plant.

Four small grains – rye, wheat, barley, and oats – were harvested at heading, milk, and soft dough stages of maturity (10). Yields of DM increased from early heading to milk stage and only slightly thereafter. Content of fiber and lignin increased and CP and IVDMD declined with advancing maturity. However, soft dough was the most mature forage harvested, so that the plateau in fiber content observed by Cher-
ney and Marten (3) may not have been achieved.

Results of animal performance with feeding cereal forages are limited. Marx (12) conducted three studies comparing cereal silage with alfalfa haylage and concluded that small grain silage could substitute for alfalfa silage. Polan et al. (14) ensiled barley at bloom, milk, or dough stages of maturity and fed these to lactating cows with concentrate. No differences in milk yield associated with forage maturity were observed for cows averaging 26.7 kg of milk daily.

Other workers (6, 16) harvested cereals for silage at various stages of maturity and moisture content. When silages were fed to cows, milk production was not affected. Comparing production responses of cows fed cereal silage across and within experiments is difficult because of the differences in silage moisture content at ensiling. Moisture content of the forage at the time of ensiling greatly affects the fermentation process, the quality of the resulting cereal silage, and ultimately, the production responses obtained (11). Additionally, if cows are not used during early lactation, changes in silage fermentation characteristics in the feed may not be discernible.

Objectives of the present study were: 1) to evaluate winter cereal (oat, wheat, and barley) and vetch mixture harvested at the bloom stage of maturity for the oats and preserved as silage on DM intake and milk yield of cows during early lactation, and 2) to evaluate the effect of maturity on the apparent digestibility of cereal-vetch hay nutrients by sheep.

**MATERIALS AND METHODS**

**Trial 1**

A commercial winter forage mixture, Germain's #2 (Germain's Inc., Fresno, CA), consisting of 48.9% common oat, 19.95% barley, 14.8% common wheat, and 14.75% common vetch was planted in fall 1985. On April 25, 1986, the forage was harvested when oats were at the bloom stage, field wilted, and ensiled in polyethylene silage bags. Forage was approximately 31% DM (n = 42, SD = 5.2) at ensiling. Based on visual appraisal at harvest, there was very little vetch present in the forage.

Forty-nine lactating Holstein cows (20 primiparous and 29 multiparous) completed the study. At calving, cows were randomly assigned to one of three dietary treatments (Table 1). Diets were 40% forage and 60% concentrate (dry basis) and were formulated to be equal in CP (18%), ADF (21%), Ca (0.87%), and P (0.57%) content on a dry basis but not equal in energy concentration. Dietary treatments (Table 1) were: 100A = forage 100% chopped alfalfa hay (AH), 66A = forage 66% AH and 34% cereal-vetch silage (CS), and 34A = forage 34% AH and 66% CS. Diet 100A was fed as a complete mixed ration. Dry ingredients for diets 66A and 34A were prepared into a mix with silage weighed and mixed by hand in the feed manger of each cow at time of feeding.

Cows were assigned at calving to dietary treatments with the experimental period including the first 15 wk of lactation. Primiparous cows were assigned randomly, but multiparous cows were assigned with consideration given to previous lactation production. Weeks of trial ran from Thursday to Wednesday. Prior to calving all cows were fed a diet consisting of oat hay offered free choice and approximately 2.2 kg of a 17% CP dairy concentrate.

Cows were fed individually for ad libitum consumption twice daily, and feed offered was recorded. Dry diet mixes and silage were sampled daily and composited by week for determination of DM in a forced air oven at 100°C. Remaining samples of diet mixes and silage were dried at 55°C, composited by 4-wk periods, ground (1 mm), and stored for later analysis. Feed refusals were recorded thrice weekly or more frequently if feed refusals were considered excessive. Orts were sampled and composited by week for each cow and dried at 100°C in a forced-air oven for determination of DM.

All cows were milked twice daily, and milk weights were recorded. Samples of milk from each cow at milking were composited by week and refrigerated in polyethylene bottles containing Preservo (D&F Control Systems, Inc., San Francisco, CA). Body weights of cows were measured weekly on a common day.

Composite feed samples were analyzed for DM, Kjeldahl N, ether extract, and ash (1). Neutral detergent fiber, ADF, cellulose, and lignin were determined according to Goering and Van Soest (9), except that for NDF determination, samples were soaked in amylase for 10 min as a preparatory step. Calcium and
TABLE 1. Ingredient composition and chemical constituents of diet components (dry basis).

<table>
<thead>
<tr>
<th>Item</th>
<th>100A diet&lt;sup&gt;1&lt;/sup&gt;</th>
<th>66A mix&lt;sup&gt;2&lt;/sup&gt;</th>
<th>34A mix&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Cereal silage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ingredients</strong></td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
<td>(%)</td>
</tr>
<tr>
<td>Alfalfa hay, chopped</td>
<td>40</td>
<td>30.5</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Beet pulp</td>
<td>12</td>
<td>4</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Corn, cracked</td>
<td>15</td>
<td>21</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Barley, rolled</td>
<td>10.5</td>
<td>14.2</td>
<td>12.8</td>
<td></td>
</tr>
<tr>
<td>Whole cottonseed</td>
<td>10</td>
<td>11.7</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td>Cottonseed meal</td>
<td>9</td>
<td>14</td>
<td>20</td>
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</tr>
<tr>
<td>Fat, grease</td>
<td>2</td>
<td>2.3</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1</td>
<td>1.1</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Trace-mineral salt</td>
<td>.5</td>
<td>.6</td>
<td>.7</td>
<td></td>
</tr>
<tr>
<td>Limestone</td>
<td>.6</td>
<td></td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td><strong>Chemical constituents</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CP</td>
<td>18.6</td>
<td>19.4</td>
<td>20.4</td>
<td>10.3</td>
</tr>
<tr>
<td>Ash</td>
<td>7.6</td>
<td>7.5</td>
<td>7.9</td>
<td>9.0</td>
</tr>
<tr>
<td>ADF</td>
<td>23.2</td>
<td>19.9</td>
<td>18.9</td>
<td>42.2</td>
</tr>
<tr>
<td>NDF</td>
<td>35.6</td>
<td>32.2</td>
<td>31.2</td>
<td>63.5</td>
</tr>
<tr>
<td>Lignin</td>
<td>4.9</td>
<td>4.7</td>
<td>4.6</td>
<td>4.1</td>
</tr>
<tr>
<td>Ether extract</td>
<td>5.8</td>
<td>6.8</td>
<td>7.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Calcium</td>
<td>.84</td>
<td>.95</td>
<td>1.15</td>
<td>.19</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>.51</td>
<td>.62</td>
<td>.66</td>
<td>.19</td>
</tr>
</tbody>
</table>

<sup>1</sup>Ingredients and chemical constituents of the complete mixed diet.  
<sup>2</sup>Ingredients and chemical constituents of the dry mix without addition of cereal silage.

phosphorus were determined by atomic absorption spectrophotometry. Milk samples were analyzed for fat by the Babcock method, total N by Kjeldahl determination, total solids by oven drying, and lactose (1).

The experimental design included repeated measurements on the same cows for 15 wk. Data were analyzed as a split-plot design (8) according to:

\[
Y = M + A_i + D_{ij} + C_{(hi)j} + (AD)_{hi} + W_k + (AW)_{hk} + (DW)_{ijk} + E_{ijk}
\]

(h = 1,2; i = 1,2,3; c = 1...49; k = 1...15) where the terms are the overall mean (M), animal age group (A), diet (D), effect of cow within age and diet groups (C), age group × diet interaction (AD), effect of cow within age and diet groups (C), age group × diet interaction (AD), week effect (W), age group × week interaction (AW), diet × week interaction (DW), age × diet × week interaction (ADW), and residual (E).

The cow term (C) represents error associated with treatment differences. Comparisons among means were by Duncan's multiple range test. Data were analyzed using the SAS (15) statistical procedures.

**Trial 2**

Winter forage mixture from the same plot used in trial 1 was harvested at four stages of maturity based on the oats in the mixture and preserved as hay. Harvest dates and maturities were April 25 – bloom, April 30 – milk, May 8 – soft dough, and May 19 – hard dough. Core samples of baled forages were obtained for chemical analysis.

Hays were chopped and pelleted, and urea was added to each diet to equalize the CP equivalent of all diets to approximately 10%. Pellets were fed to 16 wether sheep during a 21-d digestion trial consisting of a 14-d adjustment period followed by a 7-d total collection of feces (collection bags) and feed. Body weight of wethers ranged from 23 to 37 kg. Wethers were blocked into groups of four based on initial BW and randomly assigned to diets within blocks. An estimate of the TDN content of each forage maturity was made, and wethers were fed at approximately 110% of maintenance. Wethers were fed once daily and feed weights were recorded. Samples of diets were collected daily, composited weekly, and subsampled for DM determination (100°C). Re-
remainder was dried (55°C), ground (1 mm), and stored for subsequent analysis. Two wethers had a small amount of orts at conclusion of the trial. Orts were analyzed similarly to feed. Feces were collected once daily, weighed, and sampled (5% of wet weight) for determination of DM at 100°C. Remainder of the feces was dried at 55°C and composited for the 7-d period for each animal, ground (1 mm), and stored for later analysis.

Feed, orts, and fecal samples were analyzed for DM, organic matter (OM), N, crude fiber, ether extract, and ash (1). Determination of ADF, NDF, and lignin was as described in trial 1. Energy was determined in an adiabatic bomb calorimeter. Feed Ca and P were by atomic absorption spectrophotometry. In vitro DM digestibility was according to Barnes and Lynch (2).

The experiment was a randomized complete block design with block representing body weight. Wethers were randomly assigned to diet treatments within each block. Data were analyzed using SAS routines (15) and according to the following model:

\[ Y_{ij} = \mu + \alpha_i + \gamma_j + E_{ij} \]

where \( \alpha \) is the fixed effect of the \( i \)th block and \( \gamma \) is the fixed effect of the \( j \)th diet treatment.

Comparisons of treatment means were determined using Duncan’s multiple range test.

RESULTS AND DISCUSSION

Trial 1

Daily DM intake (DMI) of lactating dairy cows was lower \( (P<.05) \) on the high silage-based diet (18.7 kg/d) compared with the other two diets (20.3 kg/d) (Table 2). This may have been a consequence of gut fill. Diet 34A had the highest NDF concentration, and average consumption of NDF was similar for cows fed 66A and 34A at 7.4 kg NDF daily and 7.2 kg for cows receiving the 100A diet. The NDF concentration of diet 34A was higher than desired which likely contributed to the lower DVI. The similar intake of NDF for diets (Figures 1 and 2) may indicate that cows had reached the physical limit of gut fill, thus restricting DMI (17). Pattern of DMI was similar during the study for multiparous cows although cows receiving diets containing silage tended to exhibit lower peak intakes (Figure 3). This trend is more apparent for primiparous cows (Figure 4) in which DMI tended to decline with increasing proportion of silage in the forage component. Nitrogen intake declined as the proportion of CS in the diet increased, which reflected the total N concentration in the diets.

![Figure 1. Daily intake of NDF by multiparous cows during early lactation.](image1)

![Figure 2. Daily intake of NDF by primiparous cows during early lactation.](image2)
and DMI. This was unintended since diets were formulated to be isonitrogenous. For the total diets, the estimated CP contents were 18.6, 17.9, and 18.0% for 100A, 66A, and 34A.

Yields of milk and 4% FCM were not different among diet treatments (Table 2). Milk yields of multiparous cows during the trial were similar among diets with peak production occurring between wk 4 to 6 (Figure 5). Although not significantly different, throughout the study, primiparous cows receiving the 34A diet tended to produce less milk than those receiving other treatments.

Milk composition of fat, lactose, total solids, and ash were not affected by diet. Milk protein content was lower (P<.05) for cows fed the 34A diet than for cows fed 100A and 66A diets, which may reflect the lower energy intake of cows on this diet (5) as a consequence of reduced DMI and possibly a lower digestibility of the cereal silage compared with the alfalfa hay that the silage was replacing. Yields of all milk components were not affected by diet.

Production responses were all significantly greater for multiparous versus primiparous cows, which was expected. Intake of DM was high for both age groups, averaging 3.4 and 3.5% of BW for primiparous and multiparous cows, respectively, and average milk production performance was good.

Body weight during the trial was not significantly affected by diet treatment. Cows lost weight during early lactation, reaching a low between 3 to 5 wk of lactation (Figure 6). There was a trend for the multiparous cows receiving the 66A diet to exhibit a greater weight gain than the cows of the other two
TABLE 2. Performance of lactating cows during the first 15 wk of lactation.

<table>
<thead>
<tr>
<th>Item</th>
<th>Diet&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Parity&lt;sup&gt;2&lt;/sup&gt;</th>
<th>SE</th>
<th>1</th>
<th>2</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100A</td>
<td>66A</td>
<td>34A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DMI, kg/d</td>
<td>20.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>20.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>18.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.5</td>
<td>17.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>21.2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>ADFI, kg/d</td>
<td>4.7</td>
<td>4.6</td>
<td>4.6</td>
<td>.1</td>
<td>4.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.0&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>NDFI, kg/d</td>
<td>7.2</td>
<td>7.4</td>
<td>7.4</td>
<td>.2</td>
<td>6.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.9&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>NI, kg/d</td>
<td>.61&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.58&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.54&lt;sup&gt;c&lt;/sup&gt;</td>
<td>.01</td>
<td>.52&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.62&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Milk, kg/d</td>
<td>32.6</td>
<td>32.6</td>
<td>32.4</td>
<td>1.0</td>
<td>27.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>36.0&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>4% FCM, kg/d</td>
<td>30.7</td>
<td>31.7</td>
<td>31.0</td>
<td>1.0</td>
<td>26.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>34.1&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Fat, %</td>
<td>3.68</td>
<td>3.86</td>
<td>3.74</td>
<td>.04</td>
<td>3.83</td>
<td>3.71</td>
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<tr>
<td>Fat, kg/d</td>
<td>1.18</td>
<td>1.25</td>
<td>1.20</td>
<td>.04</td>
<td>1.04&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.64&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Protein, %</td>
<td>3.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.06&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.90&lt;sup&gt;b&lt;/sup&gt;</td>
<td>.04</td>
<td>3.06</td>
<td>2.98</td>
</tr>
<tr>
<td>Protein, kg/d</td>
<td>.99</td>
<td>.99</td>
<td>.93</td>
<td>.03</td>
<td>.84&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.06&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lactose, %</td>
<td>4.52</td>
<td>4.66</td>
<td>4.58</td>
<td>.06</td>
<td>4.63&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.55&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lactose, kg/d</td>
<td>1.48</td>
<td>1.52</td>
<td>1.48</td>
<td>.06</td>
<td>1.27&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.64&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total solids, %</td>
<td>12.62</td>
<td>12.73</td>
<td>12.30</td>
<td>.13</td>
<td>12.75&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12.42&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Total solids, kg/d</td>
<td>4.08</td>
<td>4.12</td>
<td>3.97</td>
<td>.12</td>
<td>3.49&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.44&lt;sup&gt;b&lt;/sup&gt;</td>
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</tbody>
</table>

<sup>a</sup>,<sup>b</sup>,<sup>c</sup>Means in the same row within a category with different superscripts differ (P<.05).

<sup>1</sup>Diets were 40:60 forage to concentrate (dry basis) with the forage portion comprising 100% chopped alfalfa hay (100A), 66% chopped alfalfa hay and 34% cereal silage (66A), and 34% chopped alfalfa hay and 66% cereal silage.

<sup>2</sup>Parity is primiparous (1) and multiparous (2) cows.

<sup>3</sup>DMI = Dry matter intake, ADFI = acid detergent fiber intake, NDFI = neutral detergent fiber intake, and NI = nitrogen intake.
were lower for our cereals than previous findings (4, 7) and may be related to the pelleting of the forages, method of preservation, and use of sheep as the animal model. Yield of forage at each maturity was not determined, so yield of digestible DM or energy could not be determined. Yield estimates for DM and energy are necessary to identify the optimum time of harvest. Additionally, the species of cereal might also affect recommendations. Various cultivars of rye, wheat, oats, barley, and triticale were planted in the fall and spring and harvested starting in the late boot stage and concluding at full maturity (6). Differences among cultivars and effects of maturity were significant for DM yield, nutrient composition, and IVDMD. However, the cultivar by stage of maturity effect on nutritive value was significant, indicating that maturity effects are species dependent. At similar stage of maturity, cereals vary in nutrient availability (4). Optimizing forage production from cereals will require more information on individual species as well as mixtures, yield of nutrients, and animal performance in response to feeding these forages before accurate recommendations can be provided.

Chemical constituents of lignin, CP, ADF, NDF, and CF were regressed against the dependent variables TDN, DM digestibility, energy digestibility, and digestible energy. The correlation coefficients of determination were significant for all independent variables except for CF, but coefficients were low because of the small data set. Lignin and CP demonstrated the highest correlation coefficients. Correlations for TDN with lignin, CP, ADF, NDF, and CF were $r = -.75, .75, .72, .69,$ and $-.01$. These coefficients illustrate an important point. When regression equations based on fiber constituents and calculated for legume or grass forages are used to predict the energy content of cereal forages, erroneous estimates will be obtained because most of these equations assume a negative relationship between plant fiber content and energy availability. With grass and legume forages, the fiber content increases with maturity (17) in contrast to cereal forages in which fiber and lignin initially increase with advancing maturity followed by a plateauing or even a decline in fiber content with further maturation (3). Consequently, error in prediction of energy often results in the harvesting of cereal forages at a lower quality than intended. Early work (13) reported a negative relationship between TDN content of oat hay and its lignin, crude
TABLE 4. Apparent nutrient digestibility and TDN of cereal forge pellets.

<table>
<thead>
<tr>
<th>Item</th>
<th>Bloom</th>
<th>Milk</th>
<th>Soft dough</th>
<th>Hard dough</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>55.4</td>
<td>54.6</td>
<td>51.6</td>
<td>48.9</td>
<td>1</td>
</tr>
<tr>
<td>OM</td>
<td>57.0</td>
<td>56.9</td>
<td>65.6</td>
<td>60.2</td>
<td>1</td>
</tr>
<tr>
<td>CP</td>
<td>59.6</td>
<td>60.1</td>
<td>49.5</td>
<td>46.6</td>
<td>1</td>
</tr>
<tr>
<td>Energy</td>
<td>52.8</td>
<td>53.3</td>
<td>47.7</td>
<td>41.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>53.7</td>
<td>51.7</td>
<td>39.5</td>
<td>34.6</td>
<td>1.2</td>
</tr>
<tr>
<td>ADF</td>
<td>47.5</td>
<td>44.0</td>
<td>49.7</td>
<td>42.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Cellulose</td>
<td>57.4</td>
<td>54.8</td>
<td>45.2</td>
<td>39.3</td>
<td>1.3</td>
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<td>NDF</td>
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<td>49.5</td>
<td>45.4</td>
<td>43.8</td>
<td>.8</td>
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<tr>
<td>TDN</td>
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<td>47.0</td>
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</tr>
</tbody>
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a,b,c Means with different superscripts differ (P<.05).

OM = Organic matter.

fibrer, and holocellulose composition. However, these forages were compared from jointing to dough stage. Similar to Cherney and Marten (3), Meyer and associates (13) also observed that fiber content of plant material began to plateau beyond the milk stage of maturity. Thus, the growth phase of the plant must be considered when equations are developed to predict forage quality from fiber components such as ADF and NDF. Lignin content may be the best chemical constituent to estimate forage quality of cereal forages. Equations must be developed for use with cereal forages that represent the possible stages of maturity that occur during harvest.

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