EFFECT OF SUPPLEMENTAL FEEDING OF COWS ON PASTURE ON MILK COMPOSITION AND YIELD

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SUMMARY

Thirty-five cows were used to study the effects on milk composition and production of supplementing medium-quality pasture with ground-shelled corn or corn silage. Rations were: 1) Corn; 2) corn plus silage; 3) corn (1 lb/6 lb milk) plus silage; and 4) silage. Except for corn in Ration 3, feeds were fed ad libitum for 3 hr twice daily. Trial A compared Rations 1 and 4 and employed a reversal design with 40-day treatments. Trial B was a continuous study with 12-wk treatments.

In Trial A, significant ration effects were noted for SNF, protein and fat in milk, and milk yields. Values for cows on corn and silage, respectively, were: 8.65, 3.22, 3.05%, and 39.9 lb; 8.44, 3.11, 3.65%, and 35.8 lb.

In Trial B, persistency of production was over 80% for all groups. Cows on grain and silage had highest milk yields. SNF decreased as level of corn decreased (9.16, 8.92, 8.66, and 8.42% for consecutive groups). Milk protein accounted for most of the change in SNF. Fat in milk was lower on high-corn rations (2.53, 3.23, 3.50, and 3.59% for consecutive groups). Corn silage alleviated milk fat depression noted on high-corn rations. Treatment effects on milk composition were not complete until the 6th to 8th wk of treatment.

Feeding high levels of energy to dairy cows has generally resulted in an increase in SNF in milk (principally the protein fraction) when compared with rations of normal or subnormal energy content (3, 6, 7, 10, 11, 14, 16). However, some studies have reported no difference in SNF and protein in milk from rations which varied widely in energy (2, 4). Concurrent with the increase in milk protein, there has often been noted a decrease in the fat content of the milk (3, 16). Several investigations have shown an increase in protein from feeding high levels of energy, but no change in fat (6, 11, 14). These changes in milk composition (increased protein and decreased fat) have usually been more pronounced when forage intake was very low (3, 9, 11).

In many areas, pastures supply a large portion of the forage dairy cows consume. However, very little is known on the effect of energy supplementation to cows on pasture on the major constituents of milk. Such knowledge would seem important, particularly because of the problem of low-fat milk frequently reported during the grazing season.

The purpose of this study was to investigate the effect upon milk composition and yields of varying the level and source of energy in the ration of lactating dairy cows grazing medium-quality bluegrass pasture. Of further interest was the time required for the changes in milk composition induced by ration to occur.

EXPERIMENTAL PROCEDURE

The study was divided into two trials. In Trial A (summer, 1961), 11 lactating Holstein cows in their fifth month of lactation were allotted to two groups (five and six per group). A simple reversal-type of design was used with two 40-day treatment periods. During the first period (6/22 through 7/31), one group of cows received all of the ground-shelled corn they would eat for 3 hr twice daily (2 hr prior to, and 1 hr during each milking), whereas the other group was allowed high-quality corn silage (31.1% dry matter with a grain content of about 50%) on the same basis. Treatments were switched during the second period (8/1 through 9/9). Cows were weighed for three consecutive days just prior to and at the end of treatment periods. At 12-day intervals, a daily composite of milk was sampled for composition analyses. Fat was determined by the Babcock method. A modified AOAC method (1) as adapted by Stone et al. (18) was used for determination of total solids, and total protein was analyzed according to the Kofraný Direct Steam Distillation Method (12), as modified by Stone et al. (18). Per cent solids-not-fat and lactose-mineral were determined by

Received for publication October 12, 1963.
difference. Milk production and composition data are presented for the last 30 days of each treatment period (allowing ten days adjustment).

In Trial B (summer, 1962) 24 lactating Holstein cows in their third to fifth month of lactation were used. Cows were allotted to six outcome groups (four per group) on the basis of age, stage of lactation, and production during a 21-day standardization period. During standardization all cows were on pasture and received a daily allowance of 40 lb of corn silage. Additionally, a commercial concentrate (16% C.P.) was fed at the rate of 1 lb per 3.5 lb of milk produced.

One cow from each outcome group was then assigned at random to one of the following treatment groups: 1) Ground-shelled corn; 2) ground-shelled corn plus corn silage; 3) ground-shelled corn (1 lb per 6 lb milk produced during standardization) and corn silage; and 4) corn silage. All feeds were fed ad libitum for 3 hr twice daily (2 hr prior to, and 1 hr during milking) except for the grain in Group 3. Additionally, all cows were fed 2 lb soybean meal (44% crude protein) per day.

Pasture quality and grazing schedules were similar to Trial A. Treatment period was for 86 days (6/7 through 8/31) which included 15 days of adjustment to rations. Cows were weighed for three consecutive days at the beginning and end of treatment and at bi-weekly intervals during the trial. Daily composite milk samples were taken twice during the preliminary period and at ten-day intervals thereafter. Composition analyses of milk were similar to Trial A.

On the last day of treatment, a sample of the rumen contents from three cows in each of Groups 1 and 4 and from three additional cows consuming a normal ration of hay (ad libitum) and commercial concentrate (1 lb per 3.5 lb milk produced) was taken by stomach pump approximately 5 hr after the morning feeding. A 10-ml aliquot of the sample was immediately mixed with a 2% solution of H₂SO₄. Rumen samples were stored at 40°F until analyzed for relative proportions of volatile fatty acids, according to the method described by Bruno and Moore (5).

The method of Snedecor (17) was used for statistical analyses of data and significance of difference between treatment means was tested according to Duncan (8).

RESULTS AND DISCUSSION

Pastures during both trials were of medium quality. Continuous grazing was employed and sufficient land was available to insure a liberal supply of forage during all experimental periods.

In Trial A, milk yields, SNF and its components (protein and lactose-mineral) were significantly higher for the ground corn ration (Table 1). Similar effects on milk composition have been noted in other studies where high levels of energy were fed (10, 11, 16). Concurrent with the increase in SNF, there was noted a significant decrease in fat content of milk. Milk fat depression has also been reported previously, particularly in rations containing large amounts of grain and very little forage (3, 9). No difference was noted in production of FCM or weight change of animals, despite the large differences in energy intake between the two rations. Because changes in milk composition among cows consuming high levels of grain were not complete after 40 days on treatment, a continuous-type study with a 12-wk treatment period was planned for the following year.

Supplemental TDN per pound of FCM, estimated according to Morrison (13), amounted to 0.60 and 0.30 lb for the grain and silage treatments, respectively. It is postulated that much of this difference was due to a lower intake of pasture by cows on high grain.

In Trial B, a normal decline in production was noted among all groups. Cows receiving both silage and grain maintained the highest milk yields (Table 2). The most efficient production, from a standpoint of supplemental

<table>
<thead>
<tr>
<th>Suppl. feed</th>
<th>Intake (lb/day)</th>
<th>Milk (lb)</th>
<th>FCM (%)</th>
<th>ADG</th>
<th>Fat (%)</th>
<th>Prot. (%)</th>
<th>L-M</th>
<th>SNF (%)</th>
<th>TS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground corn</td>
<td>25.6</td>
<td>39.9</td>
<td>34.2</td>
<td>0</td>
<td>3.05</td>
<td>3.22</td>
<td>5.46</td>
<td>8.68</td>
<td>11.73</td>
</tr>
<tr>
<td>Corn silage</td>
<td>46.4</td>
<td>35.8</td>
<td>33.7</td>
<td>0.2</td>
<td>3.65**</td>
<td>3.11</td>
<td>5.34</td>
<td>8.45</td>
<td>12.07*</td>
</tr>
</tbody>
</table>

* 31.1% dry matter.

* Significantly higher (P < .05).

** Significantly higher (P < .01).
TABLE 2

Effect of various supplemental feeding systems on intake, production, and body weight (Trial B) *

<table>
<thead>
<tr>
<th>Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake (lb/day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground corn</td>
<td>24.0</td>
<td>22.8</td>
<td>6.9</td>
<td>46.1</td>
</tr>
<tr>
<td>Corn silage *</td>
<td>24.1</td>
<td>46.1</td>
<td>54.1</td>
<td></td>
</tr>
<tr>
<td>Soybean meal</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Milk yields (lb/day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standardization</td>
<td>44.5</td>
<td>43.7</td>
<td>43.9</td>
<td>43.7</td>
</tr>
<tr>
<td>Treatment</td>
<td>36.6</td>
<td>39.5</td>
<td>38.0</td>
<td>35.0</td>
</tr>
<tr>
<td>% of Standardization *</td>
<td>80.4ab</td>
<td>90.4a</td>
<td>86.6ab</td>
<td>80.1b</td>
</tr>
<tr>
<td>Avg daily gain (lb)</td>
<td>1.64a</td>
<td>1.43a</td>
<td>0.58b</td>
<td>0.64b</td>
</tr>
</tbody>
</table>

* Avg for 71-day period.
* 29.9% dry matter.
* Groups not sharing a common letter are significantly different (P < .05).

TDN, was again obtained from cows fed only corn silage. Supplemental TDN per pound of FCM for Groups 1 through 4, respectively, was 0.73, 0.70, 0.46, and 0.37 lb. Substantial increases in body weight were noted for all groups; however, animals on the high-grain rations gained at a much faster rate than those in groups where grain was either limited or excluded. The greater gains accounted for some of the additional energy consumed by these groups. It is again postulated that intake of pasture was lower for cows consuming liberal quantities of grain.

The effects of ration on milk composition in Trial B were similar, but of greater magnitude than those noted in Trial A (Table 3). Maximum depression of fat content of milk among cows receiving high levels of grain was shown only after 6 wk on treatment, and greatest differences in milk protein (between Groups 1 and 4) were shown after about 7 to 8 wk on treatment (Figure 1).

As has been noted previously (3), the sensitivity for detecting small differences in milk production and composition was greater in the reversal-type study; however, the relatively long period of time required for the maximum change in milk composition to occur would seem to make a continuous-type trial more useful in studies where the effect of ration on milk constituents is of prime interest.

Cows in Group 2, which received both ground corn and corn silage ad libitum, consumed only slightly less corn than cows on corn alone (22.8 vs. 24.0 lb per day). The small amount of silage in this ration (24.1 lb) seemed to prevent partially the depression in the fat content of milk, as was noted among cows in Group 1.

Analyses for volatile fatty acids in rumen contents of cows in Group 1 revealed a much lower proportion of acetate and higher proportion of propionate than was shown for cows receiving only silage or a normal hay-grain ration (Table 4). Similar effects, but of lesser magnitude, were reported previously for lactating cows on high-concentrate, low-forage rations (3, 9). These data also tend to support those of English workers (15), in which it was shown that intraruminal infusion of propionic acid resulted in an increase in the per cent of

![Fig. 1. Average change from standardization in milk protein and fat of cows on different systems of pasture supplementation (Trial B).](image-url)
protein and SNF in milk and a decrease in milk fat.

Further studies are needed to define more clearly the effects of various factors such as concentrate-to-forage ratios, sources of concentrates and forages, and energy levels, on the major milk constituents. The physiological mechanisms involved in such changes should also be further investigated.

REFERENCES

(14) MURDOCK, F. R., HODGSON, A. S., AND WALDO,


