3-1994

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No Advantage to Delaying the Introduction of Calcium Soaps of Palm Oil Fatty Acids to Early Lactation Dairy Rations

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Ritzman Laboratory
Department of Animal and Nutritional Sciences
University of New Hampshire
Durham 03824

ABSTRACT

Holstein cows (n = 105, 39 primiparous) were blocked by parity (1 vs. >1) and assigned randomly at calving to receive supplemental Ca soaps of palm oil (2.9% fatty acids in dietary DM), commencing on DIM 1, 29, or 57 and ending on DIM 112. Effects on DMI, BW and condition score, and milk yield and composition were studied during 1 to 140 DIM. Control TMR contained 4.4% ether extract (mainly from corn meal and dried distillers grains with solubles), was fed using four grain to forage ratios, and, in early lactation, averaged 60% concentrate, 25% corn silage, and 15% wilted grass silage DM. Delayed supplementation of soaps did not promote higher dietary DMI, resulted in reduced milk fat percentage and yield, tended to decrease 4% FCM yield, and did not significantly influence milk protein content. Supplementation of soaps in wk 1 to 8 did not spare postpartum BW loss, hasten BW regain, or affect the normal change in body condition score. Ad libitum DMI and 4% FCM yield were significantly and negatively correlated (r = -0.3) with the proportion of dietary CP that was ruminally undegradable.

INTRODUCTION

The dairy industry recently has experienced increased research activity about, and on-farm use of, fat supplementation in diets for early lactation cows. Palmquist and Jenkins (11) reviewed many of the factors concerning fat supplementation that could affect microbial digestion of fiber adversely and thereby increase ruminal retention time of fiber and reduce DMI. Calcium soaps of palm oil fatty acids (CSFA) evolved as a widely used source of ruminal bypass fat that exhibits low (<20%) dissociation in the rumen at pH >6.0 and is satisfactorily stable even at ruminal pH 5.5 (17).

Holter et al. (7) used CSFA to increase dietary fat from 6.8% of DM (basal diet plus cottonseeds) to 8.7%; they found only a minor reduction (.8 to .9 percentage units) in digestibilities of NDF and ADF, no significant further reduction in DMI (16.8 vs. 16.6 kg/d), a 6% increase in NE L intake, and a 5% increase in 4% FCM yield during wk 7 and 16 postpartum. Over complete lactations, including the fat supplementation period from wk 1 to 16, however, CSFA addition apparently was advantageous for primiparous cows and detrimental for pluriparous cows for yields of milk, 4% FCM, and SCM and for the ratio of SCM to grain (7).

Schauff et al. (15) used CSFA to increase dietary fatty acids from 4.1% of DM (basal...
diet plus 16% extruded whole soybeans) to 6.4% and noted a decrease of 1.6 kg/d in dietary ad libitum DMI; doubling of the CSFA supplementation doubled the depression of DMI (3.3 kg/d). The resulting milk yield was not enhanced by CSFA addition. Effects of similar magnitude were reported by Holter et al. (6), who fed a protein and fat bypass supplement in which CSFA was the primary fat source; significant depression of ad libitum DMI was associated with significant reduction in ad libitum forage intake. Unfortunately, fiber digestibility was not measured. Grummer et al. (4) used field trials to compare several commercial fat supplements and reported somewhat lower acceptability by dairy cows of CSFA, compared with that for tallow, encapsulated dry tallow, or prilled long-chain fatty acids.

Grant and Weidner (3) increased dietary fat from 3.4 or 3.8% to 5.7 or 6.0% by addition of whole raw soybeans to rations varying in NDF content (25 vs. 29%) or in forage particle size (finely chopped alfalfa silage with or without coarsely chopped alfalfa hay). They (3) found that fat supplementation depressed DMI more in low fiber diets and somewhat more in fine forage diets and that research is needed to investigate the optimal time postpartum to commence fat feeding.

If the substitution of 0.75 kg/d of CSFA for equal DM of concentrate or of total diet increases NE\textsubscript{L} intake by about 2 Mcal/d, then only a relatively small and possibly nonsignificant decrease in DMI of 1.1 to 1.5 kg/d can counteract such NE\textsubscript{L} enhancement, depending on whether grain or forage DMI is thereby reduced. Ad libitum forage DMI starts low (~1% of BW) during the first 4 to 6 wk postpartum (6, 7) and increases abruptly thereafter; we reasoned that a ≥4-wk delay postpartum before initiation of CSFA supplementation might result in a higher ratio of forage to supplemental fat in the rumen, thus minimizing the possible adverse effects of dissociated fatty acids on fiber digestion and DMI; the desired enhancement of NE\textsubscript{L} intake would not be counteracted by reduced DMI and therefore might result in higher milk yield. Our previous findings (Figure 2 of (6)) in regard to DMI in wk 1 to 4 postpartum are consistent with this line of reasoning. Our objective was to add 3% fatty acids as CSFA to TMR, commencing at 1, 29, or 57 DIM and continuing until 112 DIM, and then to measure the effect of time of introduction of CSFA on ad libitum DMI, milk yield and composition, BW, and body condition score during the first 140 DIM in primiparous and pluriparous Holstein cows.

**MATERIALS AND METHODS**

Holstein cows (n = 105, 39 primiparous) were assigned randomly by parity (1 vs. >1) in equal numbers at calving to commence CSFA (Megalac®; Church and Dwight Co., Inc., Princeton, NJ) supplementation at 1, 29, or 57 DIM and to continue until 112 DIM. The supplement provided 3% fat (3.75% Megalac®) in the DM of a TMR that was fed for ad libitum intake and was composed of forage (63% corn silage plus 37% wilted grass silage DM) and two grain mixtures (13.3 and 34.9% CP). Grain mixtures were those described by Holter et al. (6). The 13.3% CP grain was composed primarily of corn meal (61%), corn distillers grains with solubles (15%), and wheat middlings (8.2%); the 34.9% CP grain was primarily soybean meal (48.7%), distillers grains with solubles (20%), and wheat middlings (16.8%).

Rations were balanced individually, using the University of New Hampshire Ration Balancer (9) for CP and NE\textsubscript{L} (10) every 14 d based on previous BW, DIM, milk yield, fat test, and other factors as described by Holter et al. (6); each cow’s ration composition was not necessarily changed every 14 d. The herd was sorted by percentage of grain (maximum was 66%) in the balanced (9) TMR DM of individual cows, and cows were divided into four feeding groups. Feeding group 1 usually was made up of cows requiring the maximum percentage of grain allowed in the TMR and generally constituted about one-third of the herd. Feeding groups 2, 3, and 4 usually contained about equal numbers of cows. All cows started lactation in the second highest grain group until a regular, 14-d interval fat test accompanied by a.m.-p.m. milk yield indicated a ration group change. Feeding recipes for each of the four groups were selected in such a way that about 80% of cows in the group were fed amounts considered by NRC (10) to be adequate (or more) in NE\textsubscript{L} (concentrate) except when milk fat depression occurred and the
amount of concentrate was decreased toward the mean for that group. Of course, cows in the highest group that had grain requirements greater than the imposed maximum were underfed energy, but proportions of the two grain mixtures were adjusted to provide close to adequate CP in all cases. Megalac® was added to the common TMR for the experimental rations without accounting for its contribution to TMR energy and its effect on TMR CP content; however, monosodium phosphate was cosupplemented with CSFA so that supplementation would not alter the Ca to P ratio of the diet. Sodium bicarbonate (57 g per feeding per cow) was added to the TMR for the two highest grain feeding groups.

Body weight was recorded at 14-d intervals. For ration balancing, BW was updated in the ration balancer following calving and every 28 d thereafter; between updates, the balancer projected this measured BW along standard curves by parity.

Individual feeds were weighed twice daily into a self-propelled, self-unloading, drum mixer with onboard computer, weigh cells, and orts vacuum (Data Ranger®; American Calan, Inc., Northwood, NH). Cows were fed twice daily at 0600 and 1500 h and housed in a conventional tie-stall barn with individual feed mangers and waterers. Cows were exercised daily for 1 h and milked twice daily (Jar­master®; Alfa Laval, Inc., Kansas City, MO).

Weights of milk, TMR, and orts were recorded automatically every day. Feeds were sampled every 14 d and composited by 28-d periods for analysis; orts by treatment group were sampled every 28 d. Silage DM was estimated weekly (Koster Crop Tester, North Randall, OH) to maintain desired DM proportions in the diet. Feeds and orts were analyzed by standard AOAC procedures (Table 1) except that supplement and treatment arts composites were analyzed in duplicate for fatty acids by acid hydrolysis (O'Neal Scientific Services, St. Louis, MO). The ruminally undegradable protein (RUP) contents of CP of feeds were those used in a concurrent experiment (6): 46.6, 32.0, 56, and 30% for 13.3 and 34.9% CP grains (10), corn silage, and haycrop silage, respectively. Nonfiber carbohydrate was computed as 100 – NDF – (CP + fat + ash). Milk samples were analyzed for fat (Babcock) and SNF (Golding bead test). 14-d interval milk samples were assayed for protein (Orange G dye binding).

Body condition score, using a five-point system (1 = thin to 5 = fat), in one-third units, was evaluated at calving and at 112 DIM by two persons. Standard reproductive and health records were kept. Four cows were removed from the experiment for reasons unrelated to treatment; three were shipped for foot and leg problems and one for hardware disease.

Lactation, BW, and DMI data were summarized by 28-d periods postpartum. In period 5 for all treatments, all cows were fed control (no CSFA) diets. In period 1, cows in treatments 2 and 3 were fed control diets, and, in period 2, treatment 3 cows were fed control diets. Whether or not a cow received Megalac® depended upon treatment assignment and time period and was independent of feeding group recipe. Data were analyzed first for 140-d lactation totals or means using PROC GLM of SAS (14), and main effects for this analysis were treatment, parity, and treatment by parity interaction.

For the second analysis, treatment structure was the three treatments by two parity classes for the whole plot and first four periods for the split plot. This analysis was conducted using PROC MIXED in SAS (13). The experiment was considered to be a completely randomized design. Cows within treatment by parity was used as the error term for the whole plot. Significance was declared at \( P < .10 \) unless noted otherwise.

**RESULTS AND DISCUSSION**

Ether extract content of grain mixtures (Table 1) was high because of their content of distillers grains, and the higher ether extract in the 13.3% CP grain reflected the difference in crude fat between primary ingredients (corn meal vs. solvent-extracted soybean meal) of the mixture. Grass silage was higher in crude fat than was corn silage, as expected (5, 6, 7, 8). Based on a 20% CP blend of the two grains and a 60% concentrate diet (both varied by recipe and to a lesser degree with time as discussed later), data in Table 1 suggest that control TMR DM averaged about 16.2% CP, 34% N solubility, 31% NDF, 20% forage NDF, 1.1% Ca, 2:1 Ca:P ratio, and 4.4% ether extract. Thus, the NDF and forage NDF con-
TABLE I. Chemical composition of feeds and orts (by treatment).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>DM (%)</th>
<th>N Sol (%)</th>
<th>CP (%)</th>
<th>EE (%)</th>
<th>NDF (%)</th>
<th>ADF (%)</th>
<th>Ca (%)</th>
<th>P (%)</th>
<th>NE&lt;sub&gt;L&lt;/sub&gt; (Mcal/kg of DM) (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.3% CP Grain</td>
<td>13.3</td>
<td>23</td>
<td>13.3</td>
<td>5.22</td>
<td>18.10</td>
<td>5.73</td>
<td>.95</td>
<td>.50</td>
<td>1.81&lt;sup&gt;a&lt;/sup&gt; 22</td>
</tr>
<tr>
<td>SE</td>
<td>2</td>
<td>1</td>
<td>.1</td>
<td>.07</td>
<td>.2</td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.9% CP Grain</td>
<td>90.0</td>
<td>25</td>
<td>34.87</td>
<td>4.45</td>
<td>19.67</td>
<td>8.48</td>
<td>2.89</td>
<td>1.19</td>
<td>1.83&lt;sup&gt;a&lt;/sup&gt; 22</td>
</tr>
<tr>
<td>SE</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>.08</td>
<td>.3</td>
<td>.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Megalac&lt;sup&gt;®&lt;/sup&gt;</td>
<td>96.9</td>
<td>...</td>
<td>...</td>
<td>86.88</td>
<td>...</td>
<td>...</td>
<td>8.87</td>
<td>...</td>
<td>4.94&lt;sup&gt;a&lt;/sup&gt; 2</td>
</tr>
<tr>
<td>Corn silage</td>
<td>28.7</td>
<td>66</td>
<td>7.98</td>
<td>3.34</td>
<td>45.88</td>
<td>27.05</td>
<td>.18</td>
<td>.23</td>
<td>1.44&lt;sup&gt;a&lt;/sup&gt; 23</td>
</tr>
<tr>
<td>SE</td>
<td>9</td>
<td>3</td>
<td>.3</td>
<td>.08</td>
<td>1.2</td>
<td>.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grass silage</td>
<td>31.5</td>
<td>54</td>
<td>14.52</td>
<td>4.00</td>
<td>56.88</td>
<td>37.35</td>
<td>.76</td>
<td>.34</td>
<td>1.18&lt;sup&gt;a&lt;/sup&gt; 22</td>
</tr>
<tr>
<td>SE</td>
<td>1.4</td>
<td>3</td>
<td>6</td>
<td>.11</td>
<td>1.8</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>43.1</td>
<td>...</td>
<td>14.95</td>
<td>6.96</td>
<td>35.38</td>
<td>20.14</td>
<td>1.15</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Control</td>
<td>41.1</td>
<td>...</td>
<td>14.68</td>
<td>4.06</td>
<td>37.74</td>
<td>21.26</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

1Percentage of N soluble in phosphate-bicarbonate buffer.
2Ether extract except acid hydrolysis fat for Megalac<sup>®</sup> (Church and Dwight Co., Inc., Princeton, NJ) and treatment orts.
3Analysis of composite sample in duplicate.
4Computed from ingredients using NRC (10).
5Estimated from Holter et al. (7): 5.69 Mcal/kg of fatty acids.
6Computed using equations of Harlan et al. (5).
centrations met or exceeded NRC (10) recommendations. The CP and fiber of orts suggested that orts may have contained a 15 higher proportion of forage DM than was present in the TMR, and the Ca content of treatment orts indicated that the CSFA were not sorted and selectively refused by cows. The difference in crude fat content between control and treatment orts was 2.9%, which is close to the 3% fat supplementation rate and the 2.8% theoretical increase that would result (CSFA replaced DM that contained 4.4% ether extract); results for treatment and control orts did not represent precisely the same stage of lactation because all cows received the control diet between 112 and 140 DIM (period 5).

Means for 140-d partial lactations averaged across periods are in Table 2. Ad libitum DMI was not affected by treatment. Although the treatment by lactation interaction was not significant, earlier fat supplementation tended to be associated with slightly higher total DMI in first lactation cows and with slightly lower DMI as percentage of BW in pluriparous cows; the latter observation is consistent with the finding of Schauf et al. (15) in that addition of 0, 3, or 6% CSFA to a diet already containing supplemental fat decreased DMI in multiparous cows from 4.2 to 3.9 and 3.7% of BW (P < .06). Nevertheless, we attribute this DMI trend to the treatment by lactation interaction for BW.

Grain intakes were a reflection of TMR intake and feeding group assignment. Changes in feeding group assignment were a result of prior variations in yield of 4% FCM; thus, variations in milk energy yield and, to a lesser degree, BW (i.e., energy requirements) were the cause and not the effect of changes in the proportion of concentrate in the ration. Treatment did not significantly affect grain or forage DMI (Table 2), but grain DMI tended to decrease, and forage DMI tended to increase, with decreases in 4% FCM yield, as fat supplementation was delayed.

Milk yield, protein yield, and protein percentage (Table 2) were not affected by treatment; however, yield and content of fat and percentage of SNF were higher for primiparous cows receiving CSFA supplementation immediately after calving and lower for pluriparous cows in which supplementation was delayed until 57 DIM. The reason for low SNF content of milk from primiparous cows on treatment 2 is not apparent. The effect of treatment on milk fat percentage apparently differs from that in work of Schauf et al. (15) using CSFA, with results of Schingoethe and Casper (16) using extruded oilseeds, and, indeed, with our own previous findings (7). As anticipated from previous reports (2, 7, 16), we found no evidence that delaying fat supplementation until 4 or 8 wk postpartum resulted in higher protein content of milk during the first trimester of lactation. Rather, our results agree with those of Schauf et al. (15) and suggest no significant effect of CSFA feeding on milk protein percentage.

Neither 4% FCM nor SCM yields were affected significantly by treatment, but means (Table 2) suggest that earlier introduction of CSFA supplementation was advantageous; however, yields of 4% FCM at wk 1 to 4 indicate less advantage in the pluriparous cows. The similarities across treatments for ratio of SCM yield to grain fed were consistent with proper ration energy balancing in early lactation according to requirements. The proportion of total grain contributed by the 13.3% CP mixture was similar (mean, 68.6%) among treatments and indicated that total grain DM averaged 20% CP.

Treatment means partitioned by parity category and by 4-wk periods postpartum are presented in Tables 3 to 5. Primiparous cows for which CSFA feeding was delayed 8 wk after calving tended, by chance, to weigh slightly more, and their pluriparous counterparts less, just after calving (Table 3) than did cows on other treatments. This difference was reflected in body condition scores at 1 DIM; scores on 1 DIM did not differ significantly among treatments, but pluriparous cows had lower (P = .003) condition than parity 1 cows. The latter difference is not unusual in high yielding dairy herds. The decrease in body condition score from 1 to 112 DIM was not different between parity categories or among treatments, although parity 1 cows that were started on CSFA at calving lost slightly more condition than other cows; perhaps this effect can be attributed to the lower RUP content of the diet (discussed later) of parity 1 cows in period 1. Holter et al. (8) reported that RUP appeared to spare BW loss of primiparous cows in early lactation. Figure 1 illustrates that
TABLE 2. Least squares means for yield and related traits during first 140 DIM for Holstein cows, by lactation (L) category, that were fed 3% supplemental fat as Ca salts of palm oil fatty acids (CSFA)\(^1\) commencing at the beginning of 28-d periods 1, 2, or 3 postpartum and ending at 112 DIM.

<table>
<thead>
<tr>
<th>Trait</th>
<th>L 1</th>
<th>L 1 &gt;L</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T1</td>
<td>T2</td>
<td>T3</td>
</tr>
<tr>
<td>n</td>
<td>13</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Age at calving, d</td>
<td>753</td>
<td>783</td>
<td>779</td>
</tr>
<tr>
<td>BW, kg</td>
<td>528</td>
<td>536</td>
<td>556</td>
</tr>
<tr>
<td>% of BW</td>
<td>16.58</td>
<td>16.30</td>
<td>16.08</td>
</tr>
<tr>
<td>Grain DMI, kg/d</td>
<td>3.15</td>
<td>3.07</td>
<td>2.90</td>
</tr>
<tr>
<td>13.3% CP Grain, %</td>
<td>10.34</td>
<td>10.08</td>
<td>9.62</td>
</tr>
<tr>
<td>Forage DMI</td>
<td>.695</td>
<td>.681</td>
<td>.696</td>
</tr>
<tr>
<td>% of BW</td>
<td>6.55</td>
<td>6.74</td>
<td>6.91</td>
</tr>
<tr>
<td>Corn silage DMI, %</td>
<td>1.25</td>
<td>1.26</td>
<td>1.25</td>
</tr>
<tr>
<td>% of forage DMI</td>
<td>63.4</td>
<td>63.5</td>
<td>63.3</td>
</tr>
<tr>
<td>Orts DM, % of DMI</td>
<td>21.6</td>
<td>20.0</td>
<td>20.4</td>
</tr>
<tr>
<td>Milk yield, kg/d</td>
<td>30.15</td>
<td>31.08</td>
<td>29.15</td>
</tr>
<tr>
<td>Fat</td>
<td>157.7</td>
<td>145.8</td>
<td>141.9</td>
</tr>
<tr>
<td>%</td>
<td>3.76</td>
<td>3.37</td>
<td>3.49</td>
</tr>
<tr>
<td>SNF</td>
<td>358</td>
<td>358</td>
<td>346</td>
</tr>
<tr>
<td>%</td>
<td>8.49</td>
<td>8.25</td>
<td>8.47</td>
</tr>
<tr>
<td>Protein</td>
<td>132.0</td>
<td>131.0</td>
<td>127.0</td>
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<tr>
<td>%</td>
<td>3.12</td>
<td>3.03</td>
<td>3.12</td>
</tr>
<tr>
<td>4% FCM</td>
<td>28.95</td>
<td>28.05</td>
<td>26.88</td>
</tr>
<tr>
<td>wk 1 to 4 only</td>
<td>26.96</td>
<td>25.41</td>
<td>24.43</td>
</tr>
<tr>
<td>SCM, kg/d</td>
<td>28.38</td>
<td>27.27</td>
<td>26.48</td>
</tr>
<tr>
<td>SCM:Grain (as fed), wt/</td>
<td>2.52</td>
<td>2.45</td>
<td>2.53</td>
</tr>
</tbody>
</table>

\(^1\)Megalan® (Church and Dwight Co., Inc., Princeton, NJ).
\(^2\)Treatment.
BW loss was more severe at 8 to 12 wk postpartum (about peak milk yield) in parity I cows that were supplemented with CSFA earlier in lactation, but this effect was not found in older cows \((P = .26\) for three-way interaction) and apparently was not related to DMI or FCM yield. Others (16) concluded that addition of fat to the diet in early lactation did not reduce BW losses.

Ad libitum DMI (Table 3) was not affected by treatment, nor were the interactions involving treatment significant \((P > .6)\). Forage DMI was proportional to TMR intake; forage DMI adjusted for BW (Figure 2A) virtually was identical among treatments throughout the experimental period in primiparous cows. Thus, the nonsignificant differences in total DMI favoring earlier supplementation of CSFA reflected trends \((P = .12)\) in the proportion of grain in the ration (Table 3), which, because of ration balancing, paralleled the trends \((P = .16)\) in yield of 4% FCM. In pluriparous cows (Figure 2B), forage and total DMI per unit of BW tended to be somewhat higher prior to treatment by the cows that first were supplemented with CSFA beginning 8 wk postpartum (treatment 3), and forage DMI tended to be higher thereafter; this observation can be explained by lower BW of cows in treatment 3 (Table 3) and the lower percentage of grain fed to them in the final three periods of measurement as a result of their lower FCM yield. Observed DMI was 94.8 to 99.6% of predicted (9) DMI during wk 2 to 20 when predictions were available for comparison (period data not presented).

The ratio of observed DMI to 4% FCM (Figure 3) was higher \((P < .05)\) for cows in which CSFA supplementation was delayed until 8 wk postpartum. Treatment by period by parity interaction was not significant \((P > .88)\), but the shape of curves for pluriparous cows suggested that delay of introduction of CSFA until wk 4 or 8 permitted higher DMI. This increase was followed by some depression in DMI during supplementation and then an inflection in the last 4-wk period of measurement when no CSFA were fed.

The significant treatment by period interactions (Table 4) for total CP, RUP, and ruminally degradable protein (RDP) concentrations in dietary DM were the result of dilution by CSFA supplementation; supplementation with CSFA lowered all protein by 3.75% \((3\% \text{ fat in ration OM/80}\% \text{ fat in CSFA})\). Dietary CP contents generally were not more than one percentage unit lower than NRC (10) recommen-
TABLE 3. Effect of commencing supplementation of ration of Holstein cows with Ca soap of palm oil fatty acids (3% of DM as fatty acids) at the beginning of 28 d periods (PD) 1, 2, or 3 postpartum and ending at 112 DIM on BCS, BW, DMI, and FCM, by lactation (L) category and PD, through 140 DIM (least squares means).

<table>
<thead>
<tr>
<th>Item</th>
<th>PD</th>
<th>L 1</th>
<th>L &gt;1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postpartum BW, kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum</td>
<td>3.87</td>
<td>3.85</td>
<td>4.03</td>
</tr>
<tr>
<td>Maximum</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>BCS on DIM 1</td>
<td>1.6</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>Minimum</td>
<td>3.3</td>
<td>3.6</td>
<td>4.0</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.3</td>
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Dietary Calcium Soap Introduction Time

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ditions (RUP plus RDP) during period 1 and not more than .5 percentage units lower than NRC in subsequent periods; nevertheless, CP content of diets was 2 to 3 percentage points lower than the CP percentage suggested in Appendix Table 5 of NRC (10) and lower than generally accepted as adequate by producers. The proportion of CP that was RUP ranged from 39.5 to 40.2% (not tabulated here) and, except during period 1, was somewhat higher than that suggested by NRC (10). The nonfiber carbohydrate content of ration DM ranged between 40 and 42% when CSFA were supplemented but otherwise ranged from 41 to 43%, all on the high end of the usual range for efficient microbial growth. During period 1, the RUP content of ration DM was about 87% adequate (10) when CSFA were part of the diet and 90 to 91% adequate when no supplement was fed. In periods 2 to 5, RUP was 109 to 112% and 102 to 110% adequate (10) for primiparous and older cows, respectively. The RDP concentration in dietary DM was 95% adequate relative to NRC (10) for all cows that received CSFA supplement in period 1 and 95 to 101% adequate for parity 1 cows throughout periods 2 to 5. However, RDP adequacy was only about 89 to 96% for pluriparous cows during periods 2 to 5. Although little variation occurred among cows in the RUP (5.25 to 6.75%) or RDP (7.37 to 10.65%) contents of ration DM (not tabulated here) or in the percentage of RUP in dietary CP (38.5 to 41.6%). DMI per unit of BW was correlated significantly (P < .0001) with RUP (r = .20), RDP (r = .27), and CP (r = .25) contents of the ration DM but was correlated negatively (r = -.30) with percentage of RUP in CP. Corresponding coefficients for yield of 4% FCM per day were .36, .37, .37, and -.30, respectively. These correlations tend to support the conclusion that the TMR would have benefited from a slightly higher CP percentage consisting of somewhat lower proportion of RUP.

Holter et al. (6) found that simultaneously raising dietary fat (from 4.3 to 6.0% of DM) and RUP (from 41 to 47% of CP) in the presence of ample nonfiber carbohydrate (42 to 43% of DM) from wk 5 to 8 postpartum lowered ad libitum DMI (by 1.4 and 3.2 kg/d) and lowered FCM yield (by 3 and 15%) in primiparous and pluriparous cows, respectively; Palmquist and Weiss (12) reported a
TABLE 4. Effect of commencing supplementation of ration of Holstein cows with Ca soaps of palm oil fatty acids\(^1\) (3% of DM as fatty acids) at the beginning of 28-d periods (PD) 1, 2, or 3 postpartum and ending at 112 DIM on dietary CP and nonfiber carbohydrate (NFC) percentages and intakes of ruminally degradable (RDP) and undegradable protein (RUP), by lactation (L) category and PD, through 140 DIM.

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\(^1\)Megalac® (Church and Dwight Co., Inc., Princeton, NJ).
\(^2\)Treatment.
\(^3\)All cows received the control diet during PD 5; PD 5 was not included in statistical analysis.
\(^4\)NFC = 100 - (NDF + CP + ether extract + ash), computed from least squares means.
TABLE 5. Effect of commencing supplementation of rations of Holstein cows with Ca soaps of palm oil fatty acids (3% of DM as fatty acids) at the beginning of 28-d periods (PD) 1, 2, or 3 postpartum and ending at 112 DIM on milk yield and composition by lactation (L) category and PD, and SCM to grain ratio, through 140 DIM.

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<th>T3</th>
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<sup>1</sup>Megalac® (Church and Dwight Co., Inc., Princeton, NJ).
<sup>2</sup>Treatment.
<sup>3</sup>All cows received the control diet in PD 5; PD 5 was not included in least squares means or statistical analysis.
merit in enhancing RUP in the diet when fat is supplemented.

Milk yield (Table 5) was not affected by treatment, nor were interactions involving treatment significant. However, some evidence (trend) was found for our pluriparous cows, as noted also by Schingoethe and Casper (16), that earlier postpartum introduction of CSFA supplementation delayed peak milk yield. Fat test was higher for primiparous cows that received supplemental fat from calving rather than beginning at 29 or 57 DIM; milk fat percentages of pluriparous cows were higher when supplementation commenced at 1 or 29 DIM than when it was delayed until 57 DIM. Effects involving treatment were not significant for milk protein content; SNF percentages generally paralleled protein percentages. Overall ratio of SCM yield to grain intake was not significantly affected by treatment because of individual ration balancing (9). Wu et al. (18) reported that supplementation of the diet of midlactation cows with CSFA decreased protein content, did not affect the percentages of milk fat or SNF, and increased milk yield. Our finding of no significant effect of CSFA supplementation on ad libitum OMI during 1 to 140 DIM (Table 2) or during periods 1 and 2 (1 to 28 and 29 to 56 DIM, Table 3) agrees with works of Canale et al. (1), who fed TMR based on alfalfa silage, and of Holter et al. (7), who fed grain and mixed corn-haycrop silages separately; however, our observations on OMI contrast with the findings of Schauff et al. (15), who used only multiparous cows fed TMR containing alfalfa and corn silages plus a cornsoy concentrate in 21-d period Latin square and reported dose-related depressions in OMI. Milk yield apparently was a reflection of OMI as noted also in the work of Schauff et al. (15) but not by Canale et al. (1). We found no significant effect of CSFA supplementation on ad libitum DMI during 1 to 140 DIM (Table 2) or during periods 1 and 2 (1 to 28 and 29 to 56 DIM, Table 3) agrees with works of Canale et al. (1), who fed TMR based on alfalfa silage, and of Holter et al. (7), who fed grain and mixed corn-haycrop silages separately; however, our observations on DMI contrast with the findings of Schauff et al. (15), who used only multiparous cows fed TMR containing alfalfa and corn silages plus a cornsoy concentrate in 21-d period Latin square and reported dose-related depressions in DMI. Milk yield apparently was a reflection of DMI as noted also in the work of Schauff et al. (15) and Holter et al. (7), but not by Canale et al. (1). We found no significant effect of supplementation with CSFA on milk protein concentration, thus confirming most (6, 7, 15) but not all (1, 18) previous reports; Canale et al. (1) and Wu et al. (18) found that CSFA reduced milk protein percentage but not yield.

In Table 6 are summarized the AI and conception data. No statistical evaluation was made because of the small number of observations. Overall AI per conception was acceptably low and tended to favor early introduction of CSFA into the diet, because somewhat
higher proportions of pluriparous cows conceived from first or second AI when CSFA were supplemented starting at 1 DIM, and proportionately more primiparous cows conceived from first or second AI when supplementation commenced at 29 DIM. Although the AI policy was that healthy cows were bred at first estrus after 44 DIM, the mean was about 75 DIM, and little difference was found among treatments. Schingoethe and Casper (16) found no effect of fat feeding (commencing 3 wk postpartum) on reproduction, and they reported similar days to first AI for control (72 d) and fat-supplemented cows (76 d).

CONCLUSIONS

We found no evidence that delaying the postpartum introduction of CSFA supplementation into the diet of dairy cows from 1 until 29 or 57 DIM would increase maximum DMI, but delay reduced milk fat percentage and yield, did not significantly affect milk protein content, and tended ($P < .16$) to decrease 4% FCM yield during the first 112 DIM. Early introduction of supplemental dietary CSFA did not spare BW loss postpartum, hasten regain of BW, or significantly affect the normal change in body condition score. The control TMR averaged about 4.4% ether extract in DM, primarily from corn meal and corn distillers grains with solubles as well as forages, and CSFA addition contributed 2.9% fatty acids to the ration DM.

ACKNOWLEDGMENTS

The authors thank W. E. Urban, Jr., M. L. McGilliard, and C. G. Schwab for their advice and suggestions; Donna Socha and the staff of the University of New Hampshire Dairy Teaching and Research Center for animal care; J. Whitehouse and A. Conroy for body condition scoring; S. Blanchard for analytical services; S. Ramsey for computer programming; N. Kierstead and T. Morrisette for data entry; and K. Kelley and J. Warren for manuscript preparation. Blue Seal Feeds, Inc. (Lawrence, MA) provided the CSFA.

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