Influence of Undegraded Intake Protein Supplementation on Milk Production, Weight Gain, and Reproductive Performance in Postpartum Brahman Cows

B. L. Triplett, D. A. Neuendorff, and R. D. Randel

Texas Agricultural Experiment Station, Overton 75684-0290

ABSTRACT: Eighty first-calf Brahman heifers and 51 mature Brahman cows were allotted to one of three diets based on parity, sex of calf, and breed of calf sire (Angus, Brahman, or Tuli) to evaluate rumen undegraded intake protein's (UIP) influence on production characteristics and reproductive performance. Supplements contained either 38.1% (low), 56.3% (medium), or 75.6% (high) UIP. Supplements were given from d 7 to 119 after calving to dams grazing rye-ryegrass overseeded Coastal bermudagrass pastures and with access to Coastal bermudagrass hay. Dam and calf BW and dam body condition score were recorded on d 7, 35, 63, 91, and 119 after calving. Four-hour milk production was recorded on the above days for low (n = 18), medium (n = 19), and high (n = 18) UIP animals and on d 7 and 35 for the entire group. Blood for progesterone RIA was drawn weekly and on d 6, 8, 10, and 12 after an observed estrus. Medium UIP heifers produced more \((P < .02)\) milk \((1.18 \pm .07 \text{ kg/4 h})\) than high UIP heifers \((.94 \pm .07 \text{ kg/4 h})\), but milk production in mature cows was not influenced by diet. Low UIP dams had lower \((P < .04)\) first-service conception rates \((29.2\%)\) than medium \((57.6\%)\) and tended \((P < .10)\) to have lower rates than high UIP dams \((54.6\%)\). Overall pregnancy rates tended \((P < .10)\) to be higher in medium \((61.5\%)\) and high \((56.4\%)\) UIP groups than in the low \((43.2\%)\) UIP group. Supplementing UIP at the medium rate improved first-service conception rates and tended to improve pregnancy rates.

Key Words: Undegraded Intake Protein, Beef Cattle, Reproduction, Milk Production, Sire Breed


Introduction

The success of a cow-calf enterprise largely depends on management to allow cows to maintain an average 365-d calving interval. Two factors that influence the length of the postpartum interval are nutrition and suckling.

Diet high in ruminally degradable intake protein (DIP) have been shown to be detrimental to reproduction (Canfield et al., 1990) and to transferable embryo yield (Blanchard et al., 1990) in dairy cows. However, protein supplements with a high potential for rumen escape (UIP) have been shown to improve reproduction when fed in excess of NRC recommendations (Wiley et al., 1991).

Energy and protein requirements increase by up to 33% in the lactating beef cow (NRC, 1984). Furthermore, milking ability of the beef cow is a principal factor influencing the weaning weight of calves (Neville, 1962). Supplementing dairy cattle with UIP has been shown to decrease milk fat and increase milk protein yield compared with DIP supplementation (Oldham et al., 1985; Rijpkema et al., 1990).

The objectives of this study were to determine the effects of UIP supplementation in the suckled, postpartum Brahman cow with respect to milk production, calf ADG, cow weight and body condition score changes, resumption of reproductive cyclicity, and conception rates.

Experimental Procedures

One hundred thirty-one postpartum Brahman (Bos indicus) females (80 first-calf heifers and 51 mature cows) located at the Texas A&M University Agricultural Research and Extension Center at Overton were used for this experiment. The first-calf heifers and mature cows calved between February 4 and May 21, 1992, and had been bred by artificial insemination...
(AI) techniques to either Brahman (Bos indicus),
Tuli (Sanga), or Angus (Bos taurus) bulls. After the
AI period (60 d), the females were exposed to fertile
Brahman bulls for the remainder of the 90-d breeding
season. Before calving, the females were maintained
as a single herd on rye-ryegrass overseeded Coastal
bermudagrass pastures and Coastal bermudagrass
hay.

While on study (d 7 to 119 after calving), the dams
and their calves were maintained as a single herd
except during supplement feeding and data collection.
The first-calf heifers and mature cows were sorted into
their respective treatment groups daily for group
feeding and the calves were separated until their
dams had consumed the supplement. Epididymectomy
bulls (n = 1 to 9) of mixed breeds (Brahman
and Bos taurus) equipped with chin-ball markers
were maintained with the herd to aid in estrus
detection. Upon reaching d 119 after calving, the dams
were removed from their supplemental feeding group
but were maintained in the same pasture to aid in
estrus detection and breeding. The females were
inseminated by one AI technician for 70 d to one of 10
Angus, 10 Brahman, or 9 Tuli bulls. The three breeds
of sires used were equally distributed among the first-
calf heifers and mature cows in the three treatment
groups. Pregnancy was determined by palpation per
rectum approximately 45 d after the end of the AI
season.

From February through March, the dams and their
calves were maintained as a single group on rye-
ryegrass overseeded Coastal Bermudagrass pastures
(approximately 24% CP; Grigsby et al., 1989) and ad
libitum Coastal bermudagrass hay (approximately 8%
CP; S. A. Reeves, Jr., personal communication, Texas
A&M University Agricultural Research and
Extension Center, Overton). From April through September, the
dams and their calves were maintained as a single
group on Coastal bermudagrass pastures (12 to 17%
CP; Grigsby et al., 1989). First-calf heifers and mature
cows used for this experiment were randomly
allocated to one of three treatment groups at calving
based on parity (primiparous or multiparous), sex of
sire, and breed of sire of calf (Angus, Brahman, or
Tuli).

The experimental supplements used corn for the
primary source of energy, with soybean meal and(or)
menhaden fish meal (Sealac, Zapata Haynie Corpora-
tion, Hammond, LA) as the primary source(s) of
protein. The low and medium UIP supplements also
contained dicalcium phosphate to balance for the high
calcium and phosphorous content found in fish meal
(Table 1).

The three supplements were formulated to meet or
exceed the minimum requirements for 500-kg cows
producing up to 10 kg of milk per day, during the first
3 to 4 mo of lactation, and were calculated to be
approximately isonitrogenous and isocaloric (Jurgen,
1988; Table 1).

<table>
<thead>
<tr>
<th>Item</th>
<th>Low UIP</th>
<th>Medium UIP</th>
<th>High UIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean meal, kg</td>
<td>1.25</td>
<td>.627</td>
<td>—</td>
</tr>
<tr>
<td>Fish meal, kg</td>
<td>—</td>
<td>.455</td>
<td>.909</td>
</tr>
<tr>
<td>Corn, kg</td>
<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
</tr>
<tr>
<td>Dical. phosphate, kg</td>
<td>.195</td>
<td>.100</td>
<td>—</td>
</tr>
<tr>
<td>Total, kg</td>
<td>3.50</td>
<td>3.23</td>
<td>2.95</td>
</tr>
<tr>
<td>CP, kg</td>
<td>.803</td>
<td>.778</td>
<td>.752</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>23.00</td>
<td>24.11</td>
<td>25.44</td>
</tr>
<tr>
<td>UIP, kg</td>
<td>.293</td>
<td>.434</td>
<td>.573</td>
</tr>
<tr>
<td>UIP, %</td>
<td>36.56</td>
<td>55.74</td>
<td>76.28</td>
</tr>
<tr>
<td>Dry matter, %</td>
<td>83.65</td>
<td>86.11</td>
<td>89.14</td>
</tr>
<tr>
<td>TDN, %</td>
<td>72.56</td>
<td>73.76</td>
<td>75.29</td>
</tr>
<tr>
<td>ME, Mcal/kg</td>
<td>3.18</td>
<td>2.71</td>
<td>2.75</td>
</tr>
<tr>
<td>NE, Mcal/kg</td>
<td>2.05</td>
<td>1.71</td>
<td>1.74</td>
</tr>
<tr>
<td>NE_m, Mcal/kg</td>
<td>1.77</td>
<td>1.80</td>
<td>1.83</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>1.34</td>
<td>1.46</td>
<td>1.58</td>
</tr>
<tr>
<td>Phosphorous, %</td>
<td>1.42</td>
<td>1.27</td>
<td>1.07</td>
</tr>
</tbody>
</table>

The dams were weighed and body condition scores
were recorded on d 7, 35, 63, 91, and 119 after calving.
Calves were weighed on the same schedule. Body
condition scores (BCS) were recorded on a scale of 1
to 9 (1 = thin, 9 = fat; Herd and Sprott, 1986). All the
first-calf heifers and mature cows had 4-h milk
production determined on d 7 and 35 after calving. A
subset of 57 cows (24 first-calf heifers and 33 mature
cows), evenly distributed across all three treatment
groups, also had 4-h milk production determined on d
63, 91, and 119 after calving. An injection of oxytocin
(30 IU, i.v.) and hand-milking followed by a
4-h period before a second injection of oxytocin and
hand-milking followed by weighing the milk was used
to determine 4-h milk production.

Blood samples were collected at 7-d intervals from
the cows via tail vessel puncture and processed to
yield serum. Serum progesterone was quantified by
RIA (Williams, 1989). All samples were analyzed in
one RIA and the intraassay CV was 1.51%. Estrus
activity was monitored twice daily by visual observa-
tion aided by the use of marker bulls. Additional blood
serum samples were collected on d 6, 8, 10, and 12
after first observed estrus and analyzed for progester-
one concentrations. Progesterone concentrations of
greater than 1 ng/mL for two consecutive sampling
periods were used to define the first postpartum
ovarian cycle. Postestrous samples were collected at
subsequent displays of estrus only if an animal had an
abnormal first estrous cycle length (less than 17 or
greater than 25 d).

Diet Changes

From February 11 to April 7, 1992, animals in the
three feeding groups received the daily supplement
amounts described in Table 1 and grazed rye-ryegrass
overseeded Coastal bermudagrass pastures. On March
Table 2. Daily supplemental diet reformulations on an as-fed basis

<table>
<thead>
<tr>
<th>Item</th>
<th>Low UIP</th>
<th>Medium UIP</th>
<th>High UIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean meal, kg</td>
<td>1.00</td>
<td>.50</td>
<td>—</td>
</tr>
<tr>
<td>Fish meal, kg</td>
<td>—</td>
<td>.364</td>
<td>.727</td>
</tr>
<tr>
<td>Corn, kg</td>
<td>2.05</td>
<td>2.05</td>
<td>2.05</td>
</tr>
<tr>
<td>Dical. phosphate, kg</td>
<td>.155</td>
<td>.082</td>
<td>—</td>
</tr>
<tr>
<td>Total, kg</td>
<td>3.20</td>
<td>2.99</td>
<td>2.77</td>
</tr>
<tr>
<td>CP, kg</td>
<td>.679</td>
<td>.659</td>
<td>.639</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>21.22</td>
<td>22.03</td>
<td>23.03</td>
</tr>
<tr>
<td>UIP, kg</td>
<td>.259</td>
<td>.371</td>
<td>.483</td>
</tr>
<tr>
<td>UIP, %</td>
<td>38.13</td>
<td>56.27</td>
<td>75.60</td>
</tr>
<tr>
<td>Dry matter, %</td>
<td>84.25</td>
<td>86.31</td>
<td>88.97</td>
</tr>
<tr>
<td>TDN, %</td>
<td>73.30</td>
<td>74.29</td>
<td>75.69</td>
</tr>
<tr>
<td>ME, Mcal/kg</td>
<td>2.70</td>
<td>2.72</td>
<td>2.75</td>
</tr>
<tr>
<td>NEt, Mcal/kg</td>
<td>1.70</td>
<td>1.72</td>
<td>1.75</td>
</tr>
<tr>
<td>NEm, Mcal/kg</td>
<td>1.80</td>
<td>1.81</td>
<td>1.84</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>1.17</td>
<td>1.29</td>
<td>1.35</td>
</tr>
<tr>
<td>Phosphorous, %</td>
<td>1.27</td>
<td>1.14</td>
<td>.95</td>
</tr>
</tbody>
</table>

26, two animals in the medium UIP group (Cow 3027 and a sterile marker bull) were diagnosed by a veterinarian as having laminitis. After the diagnoses, the amount of supplemental protein in each treatment group was decreased by 20% because it was felt that excess protein in the supplement and pasture contributed to the laminitis. The new diet formulations decreased daily supplemental intake and crude protein intake in the three treatment groups and changed the percentage of UIP in each treatment group (Table 2).

Statistical Analysis

The model used for this experiment was a randomized block design with unequal cell size. At calving, a dam and her calf were randomly placed into one of the three treatment groups based on 12 blocks. The 12 blocks were based on parity of the dam, sire of the calf, and sex of the calf. Continuous data were analyzed using the SAS General Linear Model procedure for analysis of variance (SAS, 1985). The PDIF option of the SAS General Linear Model procedure was used for mean separation (SAS, 1985). Proportional data were analyzed using chi-square techniques (SAS, 1985).

Results and Discussion

Dam Weight and Body Condition Score Changes

Dam weight and BCS change during the supplemental feeding portion of the study were not influenced (P > .10) by treatment group or parity (Table 3). At weaning, mature cows were heavier (P < .01; 493.4 ± 6.5 kg vs 438.5 ± 8.0 kg) and had higher (P < .01) BCS (5.7 ± .2 vs 5.1 ± .2) than first-calf heifers.

Experimental feeding stopped for each animal 119 d after calving, therefore for the last 2 to 3 mo before weaning the females had to rely on forages and body reserves for maintenance and milk production. Because the calves were weaned between September 1 and November 4, the dams had to maintain milk production and replenish body reserves on Coastal bermudagrass pastures, which declined in quality during the late summer and early fall. No forage samples were taken during the study; however, Coastal bermudagrass pastures sampled at the Overton Experiment Station during a previous study averaged between 12 and 17.1% crude protein (Grigsby et al., 1989), which would supply adequate protein for either mature cows or first-calf heifers. The level of energy provided by the Coastal bermudagrass would be adequate for mature cows but marginal for heifers (NRC, 1984). The marginal energy supply to the first-calf heifers helps to explain why the mature cows had higher BCS than the heifers at weaning. Both the mature cows and the first-calf heifers had BCS of greater than 5 (on a scale of 1 to 9) when their calves were weaned. Five is the minimal BCS at calving considered to be necessary to have acceptable reproductive success during the breeding season following calving (Herd and Sprott, 1986).

Lactation

For all dams in the study (n = 115), no differences in milk production were observed on either d 7 (P > .10) or 35 (P > .10) after calving (Table 4).

Table 3. Cow weight (kg) and body condition score change during the diet feeding portion of the study by treatment group and parity

<table>
<thead>
<tr>
<th>Item</th>
<th>Low UIP</th>
<th>Medium UIP</th>
<th>High UIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature cow weight change during diet feeding, kga</td>
<td>27.54 ± 7.79</td>
<td>34.52 ± 7.66</td>
<td>39.81 ± 7.94</td>
</tr>
<tr>
<td>Mature cow BCS change during diet feedinga</td>
<td>.22 ± .24</td>
<td>−.02 ± .23</td>
<td>.14 ± .24</td>
</tr>
<tr>
<td>Heifer weight change during diet feeding, kga</td>
<td>26.06 ± 6.43</td>
<td>35.86 ± 6.81</td>
<td>33.98 ± 6.72</td>
</tr>
<tr>
<td>Heifer BCS change during diet feedinga</td>
<td>.02 ± .20</td>
<td>.20 ± .21</td>
<td>.44 ± .21</td>
</tr>
</tbody>
</table>

aP > .10.
Table 4. Days 7 and 35 four-hour milk production (kg) × treatment group of dam

<table>
<thead>
<tr>
<th>Days postcalving</th>
<th>Low UIP n = 37</th>
<th>Medium UIP n = 39</th>
<th>High UIP n = 39</th>
</tr>
</thead>
<tbody>
<tr>
<td>7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.27 ± 0.06 kg</td>
<td>1.27 ± 0.06 kg</td>
<td>1.24 ± 0.06 kg</td>
</tr>
<tr>
<td>35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.15 ± 0.05 kg</td>
<td>1.19 ± 0.05 kg</td>
<td>1.15 ± 0.05 kg</td>
</tr>
</tbody>
</table>

<sup>a</sup>P > .10.

Additional 4-h milk production was recorded for a subset of dams (n = 57; 18 in the low UIP group, 19 in the medium UIP group, and 18 in the high UIP group) on d 63, 91, and 119 after calving. Milk production was influenced (P < .01) by parity; first-calf heifers produced less milk than mature cows (1.06 ± .04 vs 1.27 ± .03 kg/4 h, respectively). Milk production was also influenced (P < .01) by length of time after calving, increasing from d 35 (1.19 ± .03 kg/4 h) to d 63 (1.24 ± .04 kg/4 h) and then decreasing from d 91 (1.16 ± .04 kg/4 h) through d 119 (1.15 ± .03 kg/4 h) after calving. Mean 4-h milk production was greater in heifers consuming the medium UIP supplement (Treatment, P < .02) than in heifers consuming the high UIP supplement but was not different (Treatment, P > .10) from that of heifers consuming the low UIP supplement (Figure 1). Milk production among the mature cows was not influenced by treatment (Figure 1).

Differences in milk production due to parity have been seen in both beef (Marston et al., 1992) and dairy cattle (Canfield et al., 1990). Although the heifers consuming the medium UIP supplement responded to the increased UIP in their diet, heifers consuming the high UIP supplement had the lowest average milk production (Figure 1). In a study by Oldham et al. (1985), the replacement of urea in the ration by increasing levels of fish meal had a positive effect on milk production up to a point; however, the animals receiving the diet with the maximum amount of fish meal did not produce the most milk. It has been suggested that low-degradability protein sources, such as fish meal, influence animal performance by supplying extra undegraded dietary protein to the small intestine and possibly by acting as a slow-release source of nitrogen in the rumen (Hespell and Bryant, 1979). However, to optimize animal production it is still advantageous to maximize the use of the rumen and to use by-pass protein only when needed (Schingoethe et al., 1988). Animals receiving the high UIP supplement received approximately 76.3% of their supplemental intake protein as UIP, whereas the animals consuming the medium and low UIP supplements received only 55.7% and 36.6% of their supplemental intake protein as UIP, respectively. Therefore, it may be possible that the heifers consuming the high UIP supplement were not receiving enough readily degradable protein in their diet. A certain amount of degradable intake protein is required for proper rumen function and efficient utilization of fiber sources (NRC, 1985).

**Calf Performance**

Calf gain in BW and ADG during the experimental feeding period of the study was influenced (P < .01) by breed of sire; Angus-sired calves gained more (107.4 ± 3.2 kg, .96 ± .03 kg/d) than Brahman (96.3 ± 2.0 kg, .86 ± .03 kg/d) or Tuli-sired calves (92.9 ± 2.8 kg, .83 ± .03 kg/d). Calf gain in BW and ADG were also influenced (P < .02) by parity; calves from mature cows gained more (102.6 ± 2.0 kg vs 95.2 ± 2.4 kg) and had higher (P < .02) ADG (.92 ± .02 kg/d vs .85 ± .02 kg/d) than calves from first-calf heifers. Calf gain in BW and ADG was not influenced (P > .10) by treatment; calves from the low UIP group performed in a manner similar (96.0 ± 2.7 kg, .88 ± .02 kg/d) to that of calves from the medium (102.4 ± 2.7 kg, .91 ± .02 kg/d) or the high UIP (98.1 ± 2.7 kg, .88 ± .02 kg/d) groups.

Calves from mature cows weighed more (P < .04) at weaning (212.0 ± 3.2 kg) than calves from first-calf heifers (201.1 ± 4.0 kg). From birth to weaning, ADG tended to be positively influenced by dietary treatment; the calves of animals receiving the medium UIP...
supplement gained more ($P < .08$) than the calves of animals receiving either the low or high UIP diets (Figure 2). Across breeds of sire, male calves tended ($P < .10$) to weigh more at weaning ($210.8 \pm 3.8$ kg vs $202.3 \pm 3.4$ kg) and tended ($P < .09$) to gain more weight per day ($0.94 \pm 0.02$ kg/d vs $0.90 \pm 0.02$ kg/d) than female calves. Calves from Angus sires weighed more ($P < .01$) and had higher ADG ($P < .01$) at weaning ($223.8 \pm 5.3$ kg, $0.99 \pm 0.02$ kg/d) than calves from Tuli ($203.8 \pm 4.6$ kg, $0.91 \pm 0.02$ kg/d) or Brahman ($192.1 \pm 3.2$ kg, $0.86 \pm 0.01$ kg/d) sires.

The Angus and Brahman sires ($n = 10$ of each) used for the production of these calves were among the elite AI sires available for use in the United States based on their expected progeny differences for calf growth traits. The Tuli sires ($n = 9$) came from a very restricted list of available sires and no selection was made based on calf growth traits.

A breed of sire effect was observed at weaning; calves from Angus sires were the heaviest at weaning, followed by the calves from the Tuli sires. Calves from Brahman sires weighed the least. The Angus-sired calves were the heaviest throughout the study, but the Tuli-sired calves outperformed the Brahman calves from the end of the feeding period to weaning and completed the study with the second highest average weaning weight. It is generally expected that the Angus- and Tuli-sired calves would grow at a faster rate than the purebred Brahman calves, due to the heterosis exhibited by the offspring that result from the mating of two genetically diverse individuals (Legates and Warwick, 1990).

Postpartum Interval

The postpartum interval to first estrus (PPI) in dams exhibiting estrus was similar among dietary treatments ($P > .10$). Animals receiving the low, medium, and high UIP supplements had mean PPI of $89.7 \pm 6.7$, $89.5 \pm 5.0$, and $95.1 \pm 4.9$ d, respectively. The PPI of dams exhibiting estrus was longer ($P < .01$) in first-calf heifers ($107.2 \pm 5.6$ d) than in mature cows ($75.6 \pm 3.3$ d). Many studies have shown that heifers nursing their first calf have longer PPI than older cows (Wiltbank, 1970; Bellows and Short, 1978).
Table 5. First-service conception rates, pregnancy rates if inseminated, and overall pregnancy rates × treatment group of dam

<table>
<thead>
<tr>
<th>Item</th>
<th>Low UIP</th>
<th>Medium UIP</th>
<th>High UIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>First-service conception rate, %</td>
<td>29.17*</td>
<td>57.58*</td>
<td>54.55†</td>
</tr>
<tr>
<td>Pregnancy rate if inseminated, %</td>
<td>66.67</td>
<td>72.73</td>
<td>66.67</td>
</tr>
<tr>
<td>Overall pregnancy rate, %</td>
<td>43.24</td>
<td>61.54</td>
<td>56.41</td>
</tr>
</tbody>
</table>

*Means in the same row with similar superscripts differ; †P < .04, ‡P < .06.

Postestrus Progesterone Samples

Percentages of females with a normal first estrous cycle length and CL function were greater (P < .01; Figure 3) for dams receiving the medium UIP supplement than for dams receiving the low UIP supplement and tended to be greater (P < .08; Figure 3) for dams receiving the high UIP supplement than for dams consuming the low UIP supplement. The percentage of animals exhibiting an estrous cycle (normal or otherwise) with CL formation was greater (P < .02) for the females receiving the medium UIP supplement than for the females consuming the low UIP supplement and tended to be greater (P < .10) for females receiving the medium UIP supplement than for females consuming the high UIP supplement (Figure 4). More females consuming the low UIP supplement (P < .04) exhibited a silent estrus (10.8%) than females consuming the high UIP supplement (0%); females that consumed the medium UIP supplement were intermediate (2.6%). No differences were observed (P > .10) in serum progesterone concentrations (nanograms/milliliter) on d 6, 8, 10, and 12 after estrus among dams receiving the three experimental supplements (Figure 5).

Reproductive Performance

First-service conception rates were higher (P < .04) in first-calf heifers and mature cows fed the medium UIP supplement than in dams fed the low UIP supplement and tended to be higher (P < .06) in females fed the high UIP supplement than in females fed the low UIP supplement (Table 5). The percentage of dams failing to return to estrus during the breeding season was higher among females consuming the low UIP supplement (35.14%) than among females consuming the medium (15.38%; P < .05) or high UIP supplements (15.38%; P < .05). Of the animals that were inseminated, there were no differences (P > .10) in pregnancy rates among the three treatment groups (Table 5).

Armstrong et al. (1990) reported improved conception rates to all services, reduced number of services required per conception, and a tendency to reduce the interval from calving to conception when increasing levels of fish meal were used to replace a standard concentrate. Folman et al. (1981) found that by increasing the UIP content of a diet, days open were reduced and fewer breedings per conception were required.

The percentage of females ending the breeding period without being inseminated was higher for the animals consuming the low UIP supplement than for the animals consuming the medium or high UIP supplements. The majority of those not inseminated (19 out of 23) were heifers nursing their first calf. Because the mean PPI of the first-calf heifers was 107 d and the breeding season was only 70 d (May 17 to July 27), those heifers calving after mid-April were not likely to come into estrus before the end of the breeding season.

Implications

Providing first-calf heifers and mature cows with 56.4% of their supplemental protein in a ruminally undegradable form increased first-service conception rates by 28.4% over the group fed the supplement
containing only 38.1% ruminally undegradable protein. Furthermore, supplementing with 56.3% ruminally undegradable protein improved milk production in first-calf heifers and a higher percentage exhibited normal first estrous cycles. Supplementing the heifers and cows with 75.6% of their supplemental protein in a ruminally undegradable form did not improve reproductive function or milk production over 56.4%.

**Literature Cited**


