

# Milk Production and Reproductive Performance of Dairy Cows Fed Low or Normal Phosphorus Diets

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## Introduction

The NRC (1989) recommends that dairy cow diets contain at least 0.48% P for early lactation (wk 0-3), 0.41% for 40 kg/d of FCM, and other various percentages for lower production levels. These amounts include a 10% increase over the previous recommendations (NRC, 1978). Field nutritionists recommend even higher amounts. It is common to see 0.55 to 0.60% P in herd diets.

The objective of the present study was to determine if a typical diet with no supplemental P can provide adequate P for the entire lactation. The experiment is designed to be carried out for two consecutive lactations. The first lactation has been completed, and the data are presented herein.

## Materials and Methods

Forty-eight Holstein dairy cows (28 multiparous) were assigned at calving to either a low or normal P treatment. Calving was during September to October, 1996, within a seven-week period. Assignment of cows to treatments was random within parity. Cows were fed TMR in free stalls until the middle of May, 1997. Pasture provided the forage until the end of August, at which time all of the cows were dried off. The TMR was offered for ad libitum consumption during confinement and the supplement mixes at 7.0 kg/d (DM) during grazing, which accounted for approximately 40% of the total feed intake; both were fed in groups. The P content was 0.35 or 0.50% of the TMR (DM basis), and 0.35 or 0.65% of the supplements for the low and normal P treatments, respectively (Table 1). No supplemental P sources

Table 1. Ingredient and chemical composition of total mixed rations during confinement, and of supplements offered during grazing for low or normal P treatments<sup>1</sup>.

| Item                     | TMR during confinement |          | Supplements during grazing |          |
|--------------------------|------------------------|----------|----------------------------|----------|
|                          | Low P                  | Normal P | Low P                      | Normal P |
|                          | % of diet DM           |          |                            |          |
| <b>Ingredient</b>        |                        |          |                            |          |
| Alfalfa silage           | 30.0                   | 30.0     | ---                        | ---      |
| Corn silage              | 20.0                   | 20.0     | 11.0                       | 11.0     |
| High moisture ear corn   | 28.4                   | 28.0     | 74.7                       | 74.1     |
| Soybean meal             | 8.0                    | 8.0      | ---                        | ---      |
| Soybean, roasted         | 12.0                   | 12.0     | 10.6                       | 10.6     |
| Monosodium phosphate     | ---                    | 0.3      | ---                        | ---      |
| Calcium carbonate        | 1.1                    | 1.0      | 2.8                        | 1.7      |
| Dicalcium phosphate      | ---                    | 0.2      | ---                        | 1.7      |
| Salt                     | 0.4                    | 0.4      | 0.6                        | 0.6      |
| Mineral and vitamin mix  | 0.1                    | 0.1      | 0.3                        | 0.3      |
| <b>Chemical analyses</b> |                        |          |                            |          |
| CP                       | 16.9                   | 16.8     | 9.6                        | 9.4      |
| NDF                      | 33.1                   | 34.0     | 24.3                       | 25.4     |
| ADF                      | 24.5                   | 24.7     | 12.2                       | 13.3     |
| Ca                       | 0.77                   | 0.77     | 1.10                       | 1.10     |
| P                        | 0.35                   | 0.50     | 0.33                       | 0.65     |

<sup>1</sup>Total mixed rations during confinement were fed for ad libitum consumption and supplements during grazing at 7.0 kg/d to provide approximately 40% of the total intake.

Table 2. Lactation performance of cows fed diets containing low or normal P.

| Item                   | Low P <sup>1</sup> | Normal P <sup>1</sup> | SEM  | <i>P</i> |
|------------------------|--------------------|-----------------------|------|----------|
| DMI, kg/d <sup>2</sup> | 20.7               | 20.4                  | ---  | ---      |
| Milk, kg/d             | 31.7               | 29.5                  | 1.1  | 0.16     |
| 3.5% FCM, kg/d         | 31.0               | 29.6                  | 1.0  | 0.34     |
| Milk fat               |                    |                       |      |          |
| %                      | 3.41               | 3.61                  | 0.09 | 0.12     |
| kg/d                   | 1.06               | 1.04                  | 0.04 | 0.69     |
| Milk protein           |                    |                       |      |          |
| %                      | 3.05               | 3.17                  | 0.04 | 0.02     |
| kg                     | 0.93               | 0.96                  | 0.03 | 0.47     |
| BW during lactation    |                    |                       |      |          |
| Beginning, kg          | 565                | 542                   | 10   | 0.11     |
| End, kg                | 590                | 592                   | 15   | 0.93     |

<sup>1</sup>P content: 0.35% for the low and 0.50% for the normal P diets.

<sup>2</sup>Based on measurements from parturition to the time cows went on pasture (between 28 to 35 weeks in lactation)

Table 3. Concentration of P in blood serum of lactating cows fed diets containing low or normal P.

| Lactation week | Low P <sup>1</sup> | Normal P <sup>1</sup> | SEM | <i>P</i> |
|----------------|--------------------|-----------------------|-----|----------|
|                |                    | mg/dl                 |     |          |
| 1-5            | 6.0                | 7.3                   | 0.2 | 0.001    |
| 6-15           | 6.5                | 7.4                   | 0.2 | 0.001    |
| 16-25          | 5.8                | 6.4                   | 0.1 | 0.009    |
| 26-34          | 6.1                | 6.9                   | 0.2 | 0.005    |
| 35-44          | 5.6                | 5.6                   | 0.1 | 0.880    |
| Overall        | 6.0                | 6.7                   | 0.1 | 0.001    |

<sup>1</sup>P content: 0.35% for the low and 0.50% for the normal P diets.

Table 4. Reproductive measures of lactating cows fed diets containing low or normal P.

| Measure                              | Low P <sup>1</sup> | Normal P <sup>1</sup> | SEM  | <i>P</i> |
|--------------------------------------|--------------------|-----------------------|------|----------|
| Days to first estrus                 | 51.3               | 42.5                  | 3.5  | 0.09     |
| Days to first AI                     | 74.3               | 75.5                  | 3.8  | 0.83     |
| Days open                            | 112.4              | 120.1                 | 11.5 | 0.64     |
| Conception rate at first AI, %       | 29.2               | 37.5                  | ---  | ---      |
| Pregnancy rate                       |                    |                       |      |          |
| Before 120 DIM, %                    | 50.0               | 45.8                  | ---  | ---      |
| Entire lactation, %                  | 87.5               | 79.2                  | ---  | ---      |
| Services per conception <sup>2</sup> | 2.4                | 2.6                   | 0.4  | 0.71     |

<sup>1</sup>P content: 0.35% for the low and 0.50% for the normal P diets.

<sup>2</sup>Including only the cows that ultimately became pregnant (21 for Low P and 19 for Normal P).

were fed to the low P group during either regimens whereas phosphates were used to raise total dietary P for the normal P group. The level of Ca was equal between the treatments during both feeding phases.

## Results and Discussion

Averages of DMI during confinement were similar for the low and normal P groups (Table 2). Milk or 3.5% FCM production did not differ. The concentration of protein in milk was lower ( $P < 0.05$ ) for low P than normal P; however, yield did not differ. The concentrations of other milk components were not different ( $P > 0.12$ ) between P levels except for SNF, which was slightly lower ( $P < 0.05$ ) for low P. Body weight change during lactation was similar ( $P = 0.16$ ) for the two groups.

Concentration of blood serum P was lower ( $P < 0.01$ ) for cows fed the low P diet than those fed the normal P diet during most of lactation, but was similar at the end of lactation (Table 3). However, all of the

concentrations were within the normal range (4-8 mg/dl) typically seen in lactating cows.

Cows fed the low P diet were detected in estrus 8.3 d later ( $P < 0.09$ ) than cows fed the normal P diet but both were served with the first AI and conceived at similar DIM (Table 4). Feeding low P did not negatively affect pregnancy rates. Overall, reproductive efficiencies were low for both groups.

## Conclusion

Reducing dietary P from 0.50 to 0.35% for a complete lactation did not impair DMI, milk yield, or reproductive performance of dairy cows. Blood serum P concentration was lower, but within normal ranges. Inclusion of P supplements in diets was without apparent benefit, except possibly a small increase in milk protein percentage. Reducing P from the current NRC recommendations appears possible, and would be more environmentally friendly and more economical.