# Feeding Dairy Cows Copper in Grain Mixtures—A Comparison of Two Methods



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## Summary

Eleven Guernsey cows were placed on each of two copper supplementation programs at the beginning of their dry period and continued on these programs through their following lactation. One group of cows received a constant intake of copper sulfate in the form of bluestone in the amount of 0.75 grams per day. The other group was fed a grain mixture containing a constant percentage of copper sulfate, according to milk production. This grain mixture allowed for a daily intake ranging from 0.31 to 1.88 grams of copper sulfate. Average blood plasma copper values for both groups were the same at the beginning and at the end of the experimental period (constant intake group, 0.88 μg/ml; variable intake group, 0.85 to 0.86 μg/ml). A difference of 33.8 parts per million in average reduction of liver copper value between the two groups during the experimental period was not statistically significant. It appears that the supplementary levels of copper sulfate fed in this experiment can be fed in the grain mixture to dairy cows at a variable intake as effectively as when fed at a constant daily intake.

## Introduction

Cattle which consume only forage grown on certain lowlands of the Oregon Coast and lower Columbia River Valley often develop syndromes associated with impaired copper metabolism. It has been demonstrated in this area under controlled conditions that increased liver copper (Cu) content and improved animal performance could be achieved by supplementing the diet with copper (Dent and others, 1956). Analyses of forage grazed by young beef cattle showing serious scouring indicated the forage to have copper values of 5 to 10 parts per million (ppm) and molybdenum values of 3 to 10 ppm (Adams and Haag, 1957). The average blood plasma copper value of the cattle was 0.2 micrograms per milliliter (μg/ml). Appropriate copper supplementation restored copper levels and alleviated the scouring. Forage with similar concentrations of copper and molybdenum has been known to cause syndromes of impaired copper metabolism in other parts of the world (Cunningham and others, 1959; Underwood, 1966).

For the past 15 years the dairy herd at the John Jacob Astor Experiment Station has been receiving copper sulfate as powdered bluestone in the grain mixture in amounts up to 1 gram per head per day. The practice was to include the copper sulfate in one grain mixture which was fed at a constant rate each day, and to feed a second grain mixture according to milk production. A similar practice was recommended to dairymen and feed manufacturers in the area, but it was not widely adopted because it required the feeding of two grain mixtures to the milking cows.

The object of this experiment was to compare the feeding of a copper-containing trace mineral formula which is included in a typical dairy grain mixture and fed according to milk production to the feeding of a copper-containing mineral formula fed at a constant daily rate. Response to the treatments was evaluated in terms of differences in milk and milk fat production and copper values of blood plasma and liver tissue.

## Materials and Methods

Between March 1966 and September 1967, 22 purebred Guernsey cows were assigned to one of two grain-feeding treatments. The first treatment—the variable copper (V. C.) intake treatment—consisted of feeding a typical grain mixture which contained finely ground copper sulfate in the amount of 70 milligrams (mg) per pound of grain. Cows on this feeding program received four pounds of grain during all but the last two weeks of the dry period, 12 pounds of grain during the last two weeks of the dry period, and one pound of grain for every 2.5 pounds of milk produced during their lactation.

The second treatment consisted of feeding two grain mixtures. One grain mixture contained finely ground copper sulfate in the amount of 189 mg per pound of grain and was fed at the rate of 4 pounds per head per

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day during the dry period and following lactation. The other grain mixture contained no copper sulfate and was fed with the first grain mixture to increase grain intake to 12 pounds per day beginning two weeks before the calving date of each cow. After calving, this grain mixture was fed so as to allow each cow to receive one pound of the combined two grain mixtures for each 2.5 pounds of milk produced. This will be referred to as the constant copper (C. C.) intake treatment.

The composition of the grain mixtures used in this experiment were identical except for copper content. Analyses showed the copper content of the grain mixtures to be 44.1 ppm for grain used in the V. C. treatment, and 106 ppm and 14 ppm for the two grain mixtures used in the C. C. treatment.

Liver biopsy and blood samples were taken from all cows within 30 days of their dry dates for the lactation previous to the experiment, and the cows were assigned to one of the two grain-feeding treatments 30 to 60 days prior to calving. Liver biopsy and blood samples were taken again within 30 days of the dry date of the lactation included in the experiment.

## Results and Discussion

The average differences in production by cows assigned to the two feeding treatments were 121 pounds of milk and 15 pounds of fat during the 305-day lactation period (Table 1).

Liver and blood plasma copper values are presented in Table 2. The average blood plasma copper values for both feeding treatment groups was the same at the beginning and the end of the experimental period. The small difference (33.8 ppm) in liver copper reduction, although not statistically significant, may reflect the effect of an

Table 1. Milk and Milk Fat Production, Grain Consumption, and Copper Intake During One Dry Period and One 305-day Lactation of Cows on Two Copper Feeding Programs

| Cow number | Production | | Feed intake | |
|---|---|---|---|---|
| | Milk | Butterfat | Grain (365 days) | Copper from grain |
| | *lbs.* | *lbs.* | *lbs.* | *g* |
| | Variable copper (V.C.) program | | | |
| 76 | 12,859 | 658 | 5,208 | 104.3 |
| 115 | 12,139 | 710 | 5,152 | 103.2 |
| 79 | 10,441 | 490 | 4,956 | 99.2 |
| 175 | 13,972 | 822 | 5,432 | 108.8 |
| 85 | 16,477 | 956 | 6,048 | 121.1 |
| 112 | 13,283 | 810 | 5,180 | 103.7 |
| 23 | 13,124 | 868 | 5,096 | 102.0 |
| 58 | 12,965 | 726 | 5,036 | 100.8 |
| 60 | 12,078 | 664 | 4,872 | 97.5 |
| 95 | 12,319 | 710 | 5,509 | 110.3 |
| 61 | 11,599 | 568 | 5,068 | 101.5 |
| Averages | 12,841 | 726 | 5,233 | 104.8 |
| | Constant copper (C.C.) program | | | |
| 25 | 15,755 | 772 | 7,196 | 107.0 |
| 157 | 10,281 | 606 | 4,592 | 90.3 |
| 59 | 11,620 | 685 | 5,432 | 95.7 |
| 171 | 11,373 | 682 | 4,452 | 89.5 |
| 156 | 13,150 | 868 | 5,124 | 93.7 |
| 166 | 10,569 | 602 | 3,780 | 85.1 |
| 30 | 15,171 | 774 | 5,684 | 97.3 |
| 48 | 13,213 | 674 | 5,096 | 93.6 |
| 24 | 11,795 | 637 | 4,774 | 91.5 |
| 65 | 16,672 | 884 | 6,860 | 104.9 |
| 105 | 12,981 | 683 | 5,432 | 95.7 |
| Averages | 12,962 | 711 | 5,311 | 94.7 |
| Differences between groups | 121 | 15 | 78 | 10.1 |

Table 2. Liver and Blood Plasma Copper Levels of Cows Before and After Being Placed on Two Copper Supplement Feeding Programs

| Cow number | Liver copper (ppm dry wt.) | | Blood plasma copper (μg/ml) | |
|---|---|---|---|---|
| | Before | After | Before | After |
| | Variable copper (V.C.) treatment | | | |
| 76 | 150.5 | 238.7 | 0.65 | 0.66 |
| 115 | 211.7 | 351.5 | 0.62 | 0.53 |
| 79 | 105.5 | 218.0 | 0.85 | 0.81 |
| 175 | 436.0 | 178.0 | 0.92 | 0.82 |
| 85 | 380.5 | 355.3 | 1.19 | 1.12 |
| 112 | 627.5 | 422.0 | 0.97 | 0.86 |
| 23 | 324.0 | 184.0 | 0.75 | 0.88 |
| 58 | 416.0 | 309.0 | 0.75 | 0.68 |
| 60 | 634.0 | 416.5 | 0.92 | 1.09 |
| 95 | 212.0 | 239.6 | 0.80 | 0.81 |
| 61 | 233.0 | 511.0 | 0.95 | 1.17 |
| Averages | 339.2 | 311.2 | 0.85 | 0.86 |
| Change within group | | −28.0 | | +0.01 |
| | Constant copper (C. C.) treatment | | | |
| 25 | 9.4 | 323.0 | 0.63 | 1.15 |
| 157 | 11.6 | 23.0 | 0.53 | 0.79 |
| 59 | 134.8 | 273.0 | 0.98 | 0.52 |
| 171 | 300.7 | 350.0 | 0.80 | 0.86 |
| 156 | 360.0 | 208.0 | 1.04 | 0.61 |
| 166 | 396.8 | 173.0 | 1.27 | 0.96 |
| 30 | 370.5 | 269.7 | 1.24 | 0.98 |
| 48 | 467.0 | 76.7 | 1.12 | 0.82 |
| 24 | 306.0 | 61.2 | 0.55 | 0.85 |
| 65 | 330.5 | 291.0 | 0.60 | 1.13 |
| 105 | 362.0 | 321.0 | 0.96 | 1.03 |
| Averages | 277.2 | 251.4 | 0.88 | 0.88 |
| Change within group | | −61.8 | | 0.0 |

average intake of 10 grams more copper by the V. C. treatment group.

The decrease in liver copper content of both treatment groups during the experimental period suggests that both treatments supplied copper in amounts inadequate to maintain copper status in the cows, especially those having initial liver copper values of 300 ppm or more. The herd which these cows are a part of has received copper in their grain mixture similar to that described in the C. C. treatment for a period of eight years. This practice provided a daily copper intake of approximately 250 mg per cow. The average liver copper value of eight cows selected at random after the herd had been receiving copper for one year was 246.3 ppm. The decrease in liver copper of the C. C. treatment group during the experimental period, when the average daily intake of copper was 259 mg, was twice the apparent decrease for the herd over a period of seven years. In view of this, an inadequate intake of copper during the experimental period would not be a reasonable explanation for the decline in liver copper content during the experimental period for either treatment group.

The range in daily copper intake was from 79 mg to 480 mg for cows on the V. C. treatment and from 190 mg to 347 mg for cows on the C. C. treatment. The highest daily consumption of copper was 1.74 grams of commercial copper sulfate. This amount was consumed by cow 85 in the V. C. treatment for 84 days during the peak of her production. The liver copper value of this cow at the end of the experimental period was 25 ppm less than at the beginning of the experimental period. Blood plasma copper at the end of the experimental

period was 0.07 μg/ml less than at the beginning of the experimental period. This rate of consumption is well within the range considered "safe" for mature cattle (Underwood).

It may be concluded from this experiment that the variable intake, which is related to milk production and metabolic needs, was equal to if not more effective than the constant intake in preventing a depletion of liver Cu stores. This would eliminate the necessity of providing two grain mixtures or providing mineral supplement in some form other than the regular dairy grain mixture.

## References


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