# TRACING THE MINERAL FROM THE SOIL TO THE PLANT TO THE ANIMAL BLOOD

## Part IV—Effect of Urea Added to Grass Fertilized with Lime and Phosphorus on the Nutrition and Health of Goats

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### INTRODUCTION

The authors have reported previously (3) the procedure followed and the data obtained in the first experiment on the effect of unlimed and limed Para-Carib grass on the health of the goat and the chemical composition of its blood. The main results obtained during the experimental period are summarized as follows:

"Goats fed with unlimed grass ate as much as those fed with limed grass. There was a highly significant decrease in the weight of the goats, a reduction in red and white blood cells; in hematocrits and in blood iron, but there was no change in the calcium and phosphorus of blood serum. Of a total of fifteen goats, ten aborted and one died, two delivered a weak kid each but produced no milk. At the end of this experiment all goats were emaciated."

Considering that the protein deficiency in the grass might have been the cause of the malnutrition of the goats and knowing that urea has been used successfully as a protein source for ruminants by different investigators (1, 4, 5, 6, 7, 8) it was considered advisable to study if urea added to the grass would prevent the malnutrition. This paper presents data on what effect the grass fertilized with phosphorus or lime and phosphorus and mixed with urea had on the health of the animal and on the chemical composition of its blood.

### EXPERIMENTAL

The same field used in part III (2) was used. A mixture of Pará grass (*Panicum purpurascens*) and Carib grass (*Erio-*

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*chloa polystachia*) was cut daily from the corresponding strips of the unlimed, limed, phosphorus and lime-phosphorus treatments.

Sixteen one-year old virgin female goats were selected for the experiment. They were given a parasite treatment; 12 grams of phenothiazine per os. The animals were randomized into four groups, one in each pen, for the following treatments: 1. goats fed with unlimed grass, 2. goats fed with limed grass, 3. goats fed with phosphorus grass, 4. goats fed with lime-phosphorus grass.

Eight pounds of freshly chopped grass were fed to each animal. Five grams of c.p. urea (46.65% nitrogen) dissolved in 50 ml. of water were thoroughly mixed with the grass in an enamel pail before it was fed. This amount of urea was calculated to supply around 40 percent of the original amount of crude protein in the grass, known to be in previous analyses 3.5 percent on the average. As nothing was known about the response of goats to urea feeding that amount given was considered conservative.

A composite grass sample from each treatment was taken daily for moisture analysis. The amount of residual grass left daily was weighed and records of the green and dry matter consumed by each animal were kept.

Each goat was weighed three times in three consecutive days, at the middle and at the end of each month.

To induce uniform breeding, each goat was injected intramuscularly with 5 ml. of gonadin at the end of the pre-gestation period.

Blood samples were taken from each animal before and at the pre-feeding period, on January 21 and March 4, 1947 repectively; on April 8 and May 6, 1947 in the pre-gestation period; and finally on May 10 and August 25, 1947 during the gestation period. About 10 ml. of blood were drawn from each goat by a direct puncture of the jugular vein: 2 ml. for the hematological test and 8 ml. for the chemical test. Hemoglobin, iron, hematocrits, red and white blood cells were determined in the blood, and phosphorus in the blood serum, following methods previously described (3).

The experiment was started on February 17, 1947 and terminated on August 25, 1947. The six month period was divided as follows:

1. Pre-feeding (Feb. 17 to March 11, 1947)
2. Pre-gestation (March 12 to May 7, 1947)
3. Gestation (May 8 to August 25, 1947)

## PRESENTATION OF DATA AND DISCUSSION

The mean weights per goat before and during the pre-gestation period and afterwards, are given in table 1. There was no significant difference between the grass treatments for the loss in weight of the goats during the three periods.

TABLE 1.—MEAN WEIGHTS PER GOAT FED WITH GRASS AND UREA AT PRE-FEEDING, PRE-GESTATION AND GESTATION PERIODS

| Grass Treatment | Pre-feeding lbs. | Pre-gestation* lbs. | Gestation* lbs. |
|---|---|---|---|
| Check | 61.3 | 53.6 | 53.1 |
| Lime | 53.3 | 48.5 | 43.4 |
| Phosphorus | 45.3 | 40.3 | 38.7 |
| Lime-phosphorus | 56.3 | 47.9 | 47.4 |

* At 2.5 and 5.5 months, respectively, after the pre-feeding period.

The protein content of the Pará-Carib grass mixture, including the urea, varied from 5.2 to 5.8 percent on the dry basis. The amount of protein was a little above the calculated but not much higher.

The amounts of dry Pará-Carib grass consumed by each goat, during the pre-gestation period of 57 days, and per day, are reported in table 2. There was no significant difference, between the treatments for the amount of grass consumed during the pre-gestation period. In the first experiment (3), it was found that "goats fed with unlimed grass ate significantly less than those fed with limed grass."

TABLE 2.—AMOUNT OF DRY PARA-CARIB GRASS CONSUMED BY EACH GOAT DURING PRE-GESTATION PERIOD

| Grass Treatment | Dry Grass Eaten, lbs. | |
|---|---|---|
| | Per Period (57 days) | Per day |
| Check | 66.2 | 1.16 |
| Lime | 74.3 | 1.30 |
| Phosphorus | 68.1 | 1.19 |
| Lime-Phosphorus | 71.4 | 1.25 |

The hematological data, iron in blood, and phosphorus in blood serum, for the goats, before and after the pre-gestation period and after the gestation period are reported in table 3.

TABLE 3.—HEMATOLOGICAL DATA, IRON IN BLOOD, AND PHOSPHORUS IN BLOOD SERUM, FOR GOATS

| Grass Treatment | Period | Red Blood Cells Per Cu. mm. | White Blood Cells Per Cu. mm. | Hematocrits | Hemoglobin | Fe in blood | P in serum |
|---|---|---|---|---|---|---|---|
| | | X $10^3$ | | % vol. | gm. %* | mg. %* | mg. %*. |
| CHECK | Before pre-gestation.... | 21,365 | 13,225 | 42.7 | 12.9 | 62.7 | 4.0 |
| | End of pre-gestation.... | 18,733 | 15,450 | 35.5 | 11.4 | 44.9 | 2.0 |
| | End of gestation........ | 17,108 | 11,600 | 31.5 | 11.1 | 32.1 | 3.5 |
| LIME | Before pre-gestation.... | 19,073 | 11,400 | 39.1 | 11.7 | 60.1 | 3.7 |
| | End of pre-gestation.... | 18,603 | 14,763 | 37.1 | 11.9 | 45.8 | 2.0 |
| | End of gestation........ | 14,640 | 11,650 | 28.8 | 10.2 | 28.1 | 3.0 |
| PHOSPHORUS | Before preg-estation.... | 18,835 | 11,338 | 37.5 | 11.3 | 65.5 | 4.9 |
| | End of pre-gestation.... | 20,828 | 19,750 | 38.9 | 12.2 | 46.8 | 1.6 |
| | End of gestation........ | 15,153 | 11,925 | 26.9 | 9.5 | 26.2 | 4.3 |
| LIME—PHOSPHORUS | Before pre-gestation.... | 17,685 | 10,950 | 3[illegible].4 | 11.7 | 56.6 | 3.7 |
| | End of pre-gestation.... | 19,448 | 14,400 | 35.3 | 11.4 | 44.8 | 1.5 |
| | End of gestation........ | 18,303 | 11,925 | 30.3 | 10.8 | 29.6 | 3.4 |

* Grams hemoglobin and milligrams Fe or P per 100 ml. blood or serum.

There was no significant difference between the grass treatments for the hemoglobin; the red and white blood corpuscles; the hematocrits; the blood iron and the blood serum phosphorus of the goats, during the pre-feeding, pre-gestation and gestation periods. The hematocrits of the blood during the gestation period, was significantly lower than that of the pre-feeding period. The iron content of the blood during the pre-gestation and gestation periods was lower (highly significant) than that of the pre-feeding period. There was a strong tendency for the phosphorus treatment to lower the hemoglobin content during the gestation period. The inorganic phosphorus content of the blood serum during the pre-gestation period was lower (highly significant) than that of the pre-feeding and the gestation periods.

Of the sixteen goats in this experiment, one died, one aborted and only four delivered kids. All the goats lost weight and at the end of the experiment, the animals showed malnutrition symptoms.

There are some reasons to consider as the cause of this malnutrition:

1. The goats did not eat enough roughage to meet their requirement of total digestible nutrients; they only ate about one half of the roughage given. This was due probably to the quality of the roughage, or the

state of maturity. Every day the grass was one day older until the plot was finished, introducing a large variation in quality.

2. Goats like to be in the open and do not behave well in confinement or under a controlled diet. Goats like to pick and eat here and there a large variety of plants.

Before starting this experiment the five grams of urea were fed in gelatine capsules to see if it was possible to use that method of feeding. Three of the goats had tetanic spasm and orthotonus effects and one died after feeding a second capsule. Post mortem lesions revealed hemorrhagic infarcts in the liver. This toxic effect was probably due to a rapid absorption of urea in the blood stream. Nothing happened when the five grams of urea dissolved in water were mixed with the grass fed. In spite of the noted malnutrition the amount of urea was not increased fearing harmful effects that would have been worse than the malnutrition itself.

## SUMMARY AND CONCLUSIONS

The purpose of this paper was to find out what effect a low protein grass, with or without lime and phosphorus, supplemented with urea had on the health of the goat and on her blood chemical composition. Sixteen goats were separated into four groups and each group was fed with a corresponding mixture of Pará-Carib grass harvested in an acid soil that received four treatments: check, lime, phosphorus and lime-phosphorus. The goat experiment covered six months, including pre-feeding, pre-gestation, and gestation periods.

The results are summarized as follows:

1. The protein content of the grass, including the urea, varied between 5.2 and 5.8 percent on dry basis.
2. There was no significant differences, between the treatments, for the amount of grass eaten by the goats during the pre-gestation period.
3. There was no significant difference between the grass treatments, for the hemoglobin, the red and white blood corpuscles, the hematocrits, the blood iron, and the serum inorganic phosphorus of the goats, during the pre-feeding, pre-gestation and gestation periods. The hematocrits during the gestation period was significantly lower than that of the pre-feeding period of all the grass treatments. The iron content of the blood during the pre-gestation and

gestation periods was lower (highly significant) than that of the pre-feeding period. The inorganic phosphorus content of the serum, during the pre-gestation period wás lower (highly significant) than that of the two other periods.

4. Of the 16 goats in this experiment, one died, one aborted and four delivered kids.
5. All the goats, at the end of the experiment, lost weight, were emaciated thus showing malnutrition symptoms.
6. The amount of urea eaten by the goats did not correct the malnutrition if it was due to low protein content.


RESUMEN

Este trabajo se hizo con el fin de determinar qué efecto tendría en la salud de la cabra y en la composición química de su sangre, una yerba baja en proteína, con o sin cal y fósforo, y una dosis extra de nitrógeno en la forma de urea. Diez y seis cabras fueron separadas en cuatro grupos y cada grupo consumió, respectivamente, el forraje de una mezcla de yerbas Malojillo-Malojilla, cosechada en un suelo ácido el cual recibió cuatro tratamientos, a saber: testigo, cal, fósforo y cal con fósforo. El experimento duró seis meses e incluyó tres períodos: alimentación inicial, pre-gestación y gestación. Los resultados se exponen así:

1. El contenido de proteína de la yerba, incluyendo la urea, varió de 5.2 a 5.8 por ciento.
2. En el período de la pre-gestación, no hubo diferencia significativa entre los tratamientos, en cuanto a la cantidad de yerba que consumió cada grupo.
3. Durante cada uno de los tres períodos del experimento, no hubo diferencia significativa entre los tratamientos, para los siguientes componentes dé la sangre: la hemoglobina, los corpúsculos rojos y blancos, los hematócritos y el hierro; y el fósforo inorgánico del suero. En el período de gestación, los hematócritos fueron significativamente más bajos que en el período de alimentación inicial, para todos los tratamientos. El hierro en la sangre fué más bajo (altamente significativo) en los períodos de pre-gestación y gestación que en el período de alimentación inicial. El fósforo inorgánico del suero fué más bajo (altamente significativo) en el período de pre-gestación que en los otros dos.
4. De las 16 cabras usadas en el experimento, una murió, otra abortó y cuatro parieron cabritos.

5. Al finalizar el experimento todas las cabras perdieron peso y su apariencia física era muy pobre.
6. La cantidad de urea ingerida en la yerba no fué suficiente para corregir la malnutrición si ésta era debido al contenido bajo de proteínas.


## ACKNOWLEDGMENTS

This paper reports the results obtained in a cooperative research project by the Department of Soils and Animal Husbandry.

The writers wish to express their appreciation to the following members of the Animal Husbandry Department, Dr. F. E. Armstrong, Associate Veterinarian, for drawing the blood samples and performing the post-mortem examination of a goat that died after feeding urea per os; and to Mr. V. Quiñones, Assistant Chemist.

Our appreciation is also expressed to Dr. B. G. Capó, Biometrician and Head of the Agronomy and Horticulture Department, for advice in the lay-out of the experiment and in the statistical interpretation of the data.


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