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Abstract

Alfalfa, clovers, soybean meal and cottonseed meal have part of their calcium tied up as insoluble calcium oxalate. The oxalate crystals are relatively unavailable to animals and could be an important consideration in ration formulation. Extension dairymen presently are discounting total alfalfa calcium by 40 %.

Keywords

Cattlemen's Day, 1983; Report of progress (Kansas State University. Agricultural Experiment Station); 427; Beef; Calcium oxalate; Alfalfa; Clovers; Soybean meal; Cottonseed meal

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Calcium Oxalate Crystals in Feedstuffs

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Summary

Alfalfa, clovers, soybean meal and cottonseed meal have part of their calcium tied up as insoluble calcium oxalate. The oxalate crystals are relatively unavailable to animals and could be an important consideration in ration formulation. Extension dairymen presently are discounting total alfalfa calcium by 40%.

Introduction

Calcium from inorganic calcium compounds is usually more available to animals than calcium found in legumes, especially alfalfa, primarily because part of their calcium is tied up in calcium oxalate crystals. These are localized along the veins (vascular bundles) of legume leaflets and some are found in stems. Although the crystals dissolve under highly acid conditions, under normal feeding conditions the crystals pass undissolved in the feces. These calcium-containing crystals comprise 25 to 30% of the total alfalfa calcium. Research several years ago indicated that when dairy cows were fed alfalfa, they needed more calcium than when fed silage rations where most of the calcium came from inorganic sources.

Procedures

Calcium oxalate crystals were found in alfalfa, soybean meal and cottonseed meal by photographing low temperature-ashed samples with a scanning electron microscope or clover leaflets cleared with chloral hydrate with a polarized light microscope.

Calcium availability in alfalfa was measured in digestion trials using cockerels and lambs, and in a chick growth trial.

Results

Calcium oxalate crystals vary in structure with the type of plant. Figure 3.1a shows typical alfalfa crystals localized in their vascular bundles (scanning electron microscopy). They are apparently ensheathed in a cork-like (suberinized) cell wall that is virtually impossible for rumen bacteria to attack. Figure 3.1b is a red clover leaflet bundle showing the same type of calcium oxalate crystals (photographed by polarized light).

Other studies show that many of these crystals are loosened in the lower digestive tracts of cattle, sheep, hogs and chickens. By determining oxalate digestibilities, we have found that about 40% of the oxalate is digested by sheep and 10% by chickens. We assume the differences are due to rumen metabolism. We used chicks to compare nonoxalate calcium and oxalate-bound-calcium to inorganic calcium carbonate (precipitated chalk). Nonoxalate calcium was slightly more available than calcium carbonate, but both were much more available than calcium oxalate.

We also have found calcium oxalate crystals in soybean and cottonseed meals. Typical crystals of calcium oxalate from soybean meal are shown in Figure 3.1c. These crystals are shaped differently than those in alfalfa and clovers, probably because of the type of cell in which they originate.

Crystals from cottonseed meal (Figure 3.1d) have unique characteristics; they are conglomerates of several crystals. The calcium content of these two meals is low, but because part of it is tied up in crystals, they may contribute even less calcium than previously thought. Currently, we are measuring the amount of calcium tied up as oxalate in these oil meals.

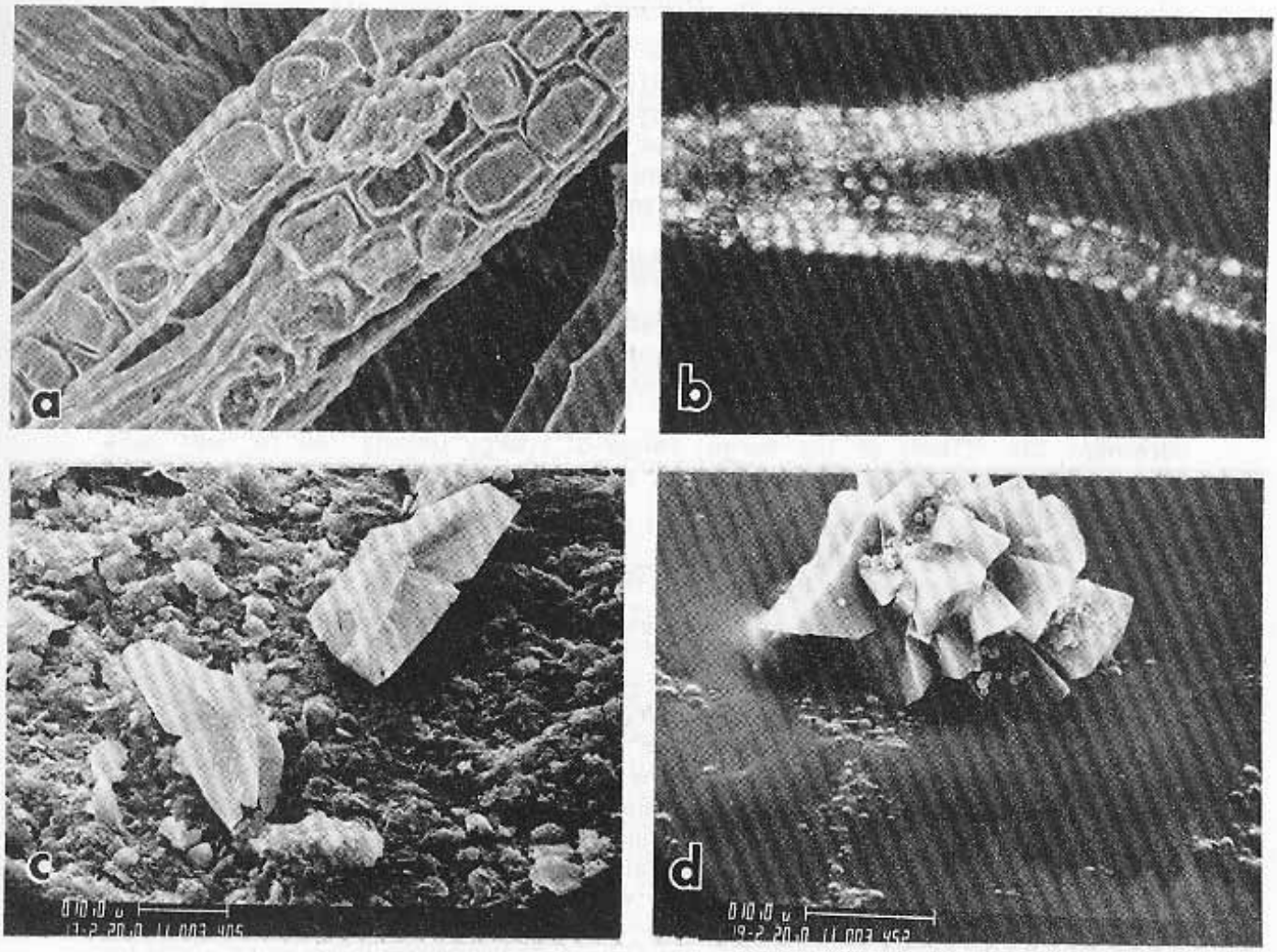

Figure 3.1. Calcium oxalate crystals. a) Scanning electron microscopy photo-micrograph of alfalfa crystals in vascular bundle. b) Polarized light micrograph of clover crystals. c) Scanning electron micrograph of soybean crystals. d) Scan- ning electron micrograph of cottonseed crystal.

(NOTE: A bibliography is available on request from the authors).