Calcium oxalate crystalluria in a goat

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- Recognition of the diverse shapes of various urine crystals is necessary for their accurate identification.
- Calcium oxalate dihydrate crystals most commonly have an octahedral or envelope shape.
- Calcium ions and oxalic acid may form calcium oxalate crystals in urine.
- Calcium oxalate dihydrate crystalluria is a risk factor for urolith formation.

As part of a routine health evaluation of an 8-month-old female Nubian goat, serum biochemical analyses and urinalysis were performed at the Clinical Pathology Laboratory of the Veterinary Teaching Hospital, College of Veterinary Medicine, Michigan State University. Clinical abnormalities had not been reported. Serum biochemical values were within reference ranges with the exception of increased **sorbitol dehydrogenase (SDH)** activity (91 U/L; reference range, 9.4 to 57.3 U/L)[1] that suggested hepatocellular damage. Concentrations of blood calcium (9.6 mg/dl), total CO_2 (24 mmol/L), and indicators of urinary system dysfunction such as urea nitrogen, creatinine, and phosphorus concentrations were within reference ranges. An aliquot of voided urine was hypersthenuric (specific gravity, 1.041), acidic (pH, 6.0), and did not have detectable protein, glucose, ketones, bilirubin, or occult blood. Urine urobilinogen concentration was 0.2 mg/dl, and light microscopic examination of urine sediment did not reveal erythrocytes or leukocytes. Numerous colorless crystals in urine sediment that were cuboidal-bipyramidal were considered to be typical of calcium oxalate dihydrate crystals.[2] Also numerous were 3-dimensional rectangular or block-shaped crystals that in mathematical terminology are referred to as a "rectangular parallelepiped" (**Fig 1**). The end faces of most block-shaped crystals also had a perceptible bipyramidal configuration. Few crystals formed crosses. Similar features were revealed by scanning electron microscopy (**Fig 2**). The mineral composition of the crystals was confirmed as calcium oxalate dihydrate by energy dispersive X-ray microanalysis.

There are few reports of urinary crystals or uroliths in goats[3-7]; calcium oxalate dihydrate crystals have not been described commonly, and may be of several different forms. The most commonly recognized form is colorless and characteristically octahedral or envelope-shaped.[2] Cuboidal-bipyramidal crystals have been reported in dogs,[2] and cuboidal crystals have also been reported in horses.[8] Calcium oxalate monohydrate crystals may be seen concomitantly with calcium oxalate dihydrate crystals. Calcium oxalate monohydrate crystals may have a spindle, dumb-bell or hemp-seed shape.[2] However, the rectangular parallelepiped calcium oxalate dihydrate crystals of the goat described here were unique and, to our knowledge, have not been reported in any species.

Calcium oxalate crystals may develop in acidic, neutral, or alkaline urine.[2] Repeated detection of large numbers of calcium oxalate crystals (monohydrate or dihydrate) in fresh urine should suggest that hypercalciuric or hyperoxaluric disorders be considered. Increased concentrations of blood calcium and oxalic acid result in hypercalciuria and hyperoxaluria.[9] In

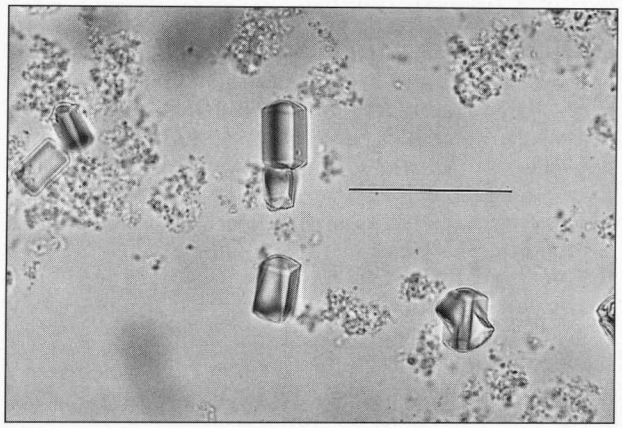

Figure 1— Photomicrograph of unstained urine sediment from an 8-month-old Nubian goat. Notice calcium oxalate dihydrate crystals. Bar = 10 μm.

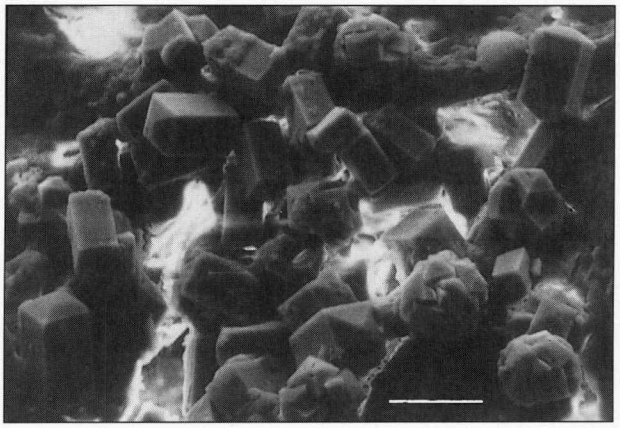

Figure 2—Scanning electron micrograph of urine sediment from an 8-month-old Nubian goat. Notice rectangular parallelepiped calcium oxalate dihydrate crystals with bipyramidal end faces. Bar = 10 μm.

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urine that is supersaturated with calcium and oxalic acid ions, formation of calcium oxalate monohydrate or calcium oxalate dihydrate crystals is a risk factor for formation of calcium oxalate uroliths. The most commonly recognized predisposing factor for hypercalciuria in goats is high dietary calcium concentration. Oxaluria is usually associated with hyperoxalemia and may be associated with high concentrations of dietary oxalates or intoxication with oxalate-forming compounds such as ethylene glycol. Ethylene glycol toxicity has been reported in a pygmy goat[10] and administration of large amounts of ascorbic acid was suspected to cause calcium oxalate formation in a Toggenburg doe.[11]

The mineral forms of calcium oxalate monohydrate (weddellite) and dihydrate (whewellite) have been reported as components of uroliths in grazing ruminants (sheep and cattle) in Australia[12,13] and in a pygmy goat in the United States.[14] Uroliths that contained calcium oxalate and silica were reported in Saanan goats in Tanzania.[5] Other uroliths in goats include those composed of struvite,[4,6] calcium carbonate,[3] calcium apatite,[3] and silicate.[7] Several conditions predispose ruminants to urolith formation.[15,16]

The urine crystals of the case reported here were unlikely to have formed in vitro during the brief time that the sample was in transit to the laboratory. We hypothesize that the calcium oxalate crystals resulted from a diet (second-cut hay and a grain mixture formulated specifically for goats) containing calcium and oxalic acid. Treatment was not administered, and the goat remained healthy during the ensuing year.

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