

# OXALATE NEPHROSIS IN A POPULATION OF SOUTH AUSTRALIAN KOALAS (*Phascolarctos cinereus*)

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## ABSTRACT

Renal disease had been reported to occur at high prevalence in the koala population of the Mount Lofty Ranges in South Australia, but the cause was unclear. Kidney crystals consistent with calcium oxalate had been observed in several koalas, suggesting that oxalate nephrosis may occur. The aims of this study were to describe renal pathological changes and confirm oxalate deposition in these koalas and also to investigate possible causes of disease.

Oxalate nephrosis was found in 55% of 51 captive and rescued wild koalas from the Mount Lofty population. Renal histopathological changes associated with crystals included intratubular and interstitial inflammation, tubule dilation, glomerular atrophy, tubule loss and cortical fibrosis. Renal insufficiency was confirmed in affected koalas by azotaemia in association with poorly concentrated urine, and decreasing urine specific gravity was significantly associated with increasing severity of histopathological changes. The number of males and females, and captive and rescued wild koalas showing oxalate nephrosis was similar. Age was not found to be a predisposing factor, but many koalas <2 years old were affected. Urinary crystals in all koalas with oxalate nephrosis showed an atypical morphology for calcium oxalate. Hyperoxaluria was also found, suggestive of a primary cause for disease.

To investigate whether a dietary cause existed for oxalate nephrosis in koalas, oxalate concentration was measured in juvenile, semi-mature and mature leaves from manna gum (*E. viminalis*), red gum (*E. camaldulensis*), SA blue gum (*E. leucoxyton*) and messmate stringybark (*E. obliqua*) in spring. Eucalypt leaves were found to be low in oxalate overall (<1% dry weight) with occasional samples that were higher in oxalate. Mount Lofty eucalypts were found to have higher oxalate content overall than those eaten by koalas in Moggill, Queensland, where the prevalence of oxalate nephrosis is lower.

To investigate whether endogenous overproduction of oxalate could occur due to an inherited liver enzyme dysfunction, similar to primary hyperoxaluria type I in humans, the activity of alanine: glyoxylate aminotransferase (AGT) was measured in liver samples. Koalas with oxalate nephrosis showed no decrease in AGT activity compared with samples from unaffected Queensland koalas, indicating normal activity of this enzyme.

Water content of eucalypt leaves was also measured, since dehydration is a key risk factor for renal calcium oxalate deposition. Mount Lofty eucalypt leaves were found to be lower in moisture in autumn compared with those in Queensland, particularly juvenile and semi-mature leaves of *E. obliqua* and *E. leucoxylon*.

The pathological, histopathological and clinicopathological description of oxalate nephrosis in koalas provided by this study will assist veterinarians and pathologists in the diagnosis of this disease. Investigation of the pathogenesis of oxalate nephrosis in the Mount Lofty koala population found that neither high eucalypt leaf oxalate or decreased AGT activity were the primary cause. Further research is needed, but based on the low genetic diversity of the Mount Lofty koalas, an inherited pathogenesis of oxalate nephrosis remains likely. To decrease the risk of oxalate nephrosis, water supplementation should be provided for captive and wild Mount Lofty koalas during the hot, dry summer.

## DECLARATION

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution in my name and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide.

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## LIST OF ABBREVIATIONS

AGT	alanine: glyoxylate aminotransferase
ALT	alanine aminotransferase
AST	aspartate aminotransferase
DW	dry weight
EDX	energy dispersive X-ray analysis
ELISA	enzyme-linked immunosorbent assay
GGT	gamma glutamyl transferase
HCl	hydrochloric acid
HE	haematoxylin and eosin stain
HPLC	high performance liquid chromatography
IRS	infrared spectroscopy
KI	Kangaroo Island
ML	Mount Lofty, South Australia
N	number of samples
NSW	New South Wales
PCR	polymerase chain reaction
Qld	Queensland
SA	South Australia
SD	standard deviation
SE/SEM	standard error of the mean
SEM	scanning electron microscopy
TP	total protein
TWC	tooth wear class
USG	urine specific gravity
Vic	Victoria

Note: In 2009, *Chlamydophila* spp. which affect koalas (*C. pecorum* and *C. pneumoniae*) were reclassified as *Chlamydia*, hence both of these terms are used in this thesis.