

Understanding Urinary Relative Supersaturation

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YOU HAVE ASKED...

Some pet foods undergo urinary relative supersaturation (RSS) testing. What is RSS, and how important is it in nutritional management of urolithiasis in cats and dogs?

THE EXPERTS SAY...

Uroliths, commonly called *stones*, are composed of different materials or crystal types (eg, struvite, calcium oxalate, urate). Therapy of urolithiasis is most successful if urolith type can be identified and specific treatment for stone

components begun. Nutrition plays an important role managing urolithiasis in cats and dogs. Unfortunately, many veterinarians are uncertain of what urinary RSS means when it is part of a urinary diet option and why it can be considered when choosing a nutritional intervention for a known or suspected urolith type.

In order to understand RSS, a quick refresher on saturation may be helpful. A saturated solution is defined as a solution in which no more solvent can be dissolved. The term *supersaturated* describes a solution that contains more of the material than could be dissolved by the solvent under normal circumstances. Similarly, relative supersaturation values

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of a pet food predict the supersaturation (ie, crystallization potential) of certain minerals in the urine to form a urolith.

RSS estimates on pet foods are currently available only for struvite and calcium oxalate. RSS testing for other urolith crystals (eg, urate, cystine, silica) are not routinely performed. Clinicians should not assume that RSS values for calcium oxalate or struvite provide effective RSS values for all other urolith types (see **Urolith Production Basics**).

RSS Trials

The trial phase of RSS determination involves feeding the diet being tested on dogs and cats. This diet (and no other food or treats) is fed for a defined time period (≥ 2 weeks) to allow for a complete diet transition. After, and while the animals are still eating the diet, all of the cat's or dog's urine is collected over a 1- to 7-day period. Urine is analyzed for crystal components (eg, magnesium, phosphorus, calcium), and this information is entered into a computer program. The program also factors in urine pH and generates a number—the RSS—for the individual eating that diet. RSS is determined based on the specific urinary factors for the individual eating that specific diet over the time period, then averaged to give a final RSS value that combines the results of all dogs or cats in the trial. Trial methods may differ between pet food companies and independent researchers.

Two computer software packages (Equil, SuperStat) are available for RSS calculation, and there is some variation in their data collection methodology.^{1,2} Slightly different RSS results are generated by the different trial phases, analysis type, and computer software programs. As such, RSS results and the interpretation of these differ between pet food manufacturers and independent researchers.¹ RSS product calculation is not routinely made public by manufacturers, which makes

UROLITH PRODUCTION BASICS

The classic “sugar” solution example is used as an analogy for risk of stone (ie, urolith) formation due to urine saturation with specific crystals. If sugar is slowly added to a cup of warm water, the sugar initially dissolves quickly and there is no chance for individual granules to aggregate or stick together. The solution is *undersaturated* for sugar.

As more sugar is added, a point is reached when the sugar no longer dissolves but it becomes visible, or *oversaturated*. After this, the more sugar added to the water, the more the sugar crystals will aggregate, resulting in a sticky sugar clump. Similarly, RSS testing defines the quantity of urine saturated with a specific crystal type and the subsequent risk of a clump or stone.

trial result interpretation difficult for practitioners (**Table 1**, next page).

Desired RSS

Despite these differences in research methods, there is consensus on the RSS numbers desired to prevent or dissolve the most common urolith types: struvite and calcium oxalate. As such, there are different practical and clinically relevant interpretations of these RSS numbers to help veterinary teams use RSS information in a “urinary diet” (or other diet with RSS testing) as part of their toolkit for effective management of struvite and calcium oxalate urolithiasis (**Table 2**, next page).

Struvite (Cats)

To dissolve struvite uroliths, the ideal RSS diet for dissolution has an RSS for struvite at or < 1 (ie, undersaturated for struvite).^{1,3,4} To aid in the prevention of struvite stones, the target is an RSS at or < 2.5 (ie, metastable for struvite).^{1,3,4}

Calcium Oxalate (Cats & Dogs)

It is not possible to dissolve calcium oxalate

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RSS = relative supersaturation

TABLE 1

COMMERCIALY AVAILABLE RSS-TESTED VETERINARY DIETS*

Manufacturer	RSS Testing Software	Diet for Struvite Management	Diet for Calcium Oxalate Management
CANINE			
Hill's (hillsvet.com)	▶ Equil	▶ s/d and c/d (wet and dry)	▶ c/d Multicare wet ▶ u/d wet and dry
Purina (purinaveterinarydiets.com)	▶ Equil	▶ UR (wet and dry)	▶ UR (wet and dry)
Rayne Clinical Nutrition (raynenutrition.com)	▶ Equil	▶ Adult Health RSS (wet and dry)	▶ Adult Health RSS (wet and dry)
Royal Canin (royalcanin.com)	▶ SuperStat	▶ SO (wet and dry)	▶ SO (wet and dry)
FELINE			
Hill's	▶ Equil	▶ c/d Multicare (wet and dry) and s/d	▶ c/d Multicare (wet and dry)
Purina	▶ Equil	▶ UR St/Ox (wet and dry)	▶ UR St/Ox (wet and dry)
Rayne Clinical Nutrition	▶ Equil	▶ Adult Health RSS (wet and dry)	▶ Adult Health RSS (wet and dry)
Royal Canin	▶ SuperStat	▶ Royal Canin SO (wet, chunks and gravy, and dry)	▶ Royal Canin SO (wet, chunks and gravy, and dry)

* Additional diets for management of other conditions have also undergone RSS research. Contacting the manufacturer is advised to obtain specific results and to ensure urine saturation goals have been achieved. Results must be interpreted in light of RSS trial details (ie, RSS trial ranges, medians, values, and averages) to understand methodology and trial criteria with respect to urolith type. RSS analyses need to be repeated after any diet modifications. At this time (January 2016), RSS research trial results can be found for only 1 of the pet food companies listed above.

TABLE 2

RELATIVE SUPERSATURATION POINTS FOR STRUVITE DISSOLUTION OR STRUVITE & CALCIUM OXALATE PREVENTION

Zones of Saturation	Struvite RSS	Calcium Oxalate
Undersaturated	RSS for struvite at or <1 (able to dissolve pure struvite stones)	RSS for calcium oxalate <10
Metastable	RSS for struvite 1-2.5	RSS for calcium oxalate: Cats, 10-12; dogs, 10-14
Oversaturated	RSS >2.5	RSS: Cats, >12; dogs, >14

stones. The ideal RSS diet to help decrease the risk of calcium oxalate urolith formation will have an RSS for calcium oxalate <14 dogs,^{1,5,6} <12 cats^{1,4} (metastable 10-14 dogs, 10-12 cats), and ideally <10 (ie, undersaturated).

Other

In addition to genetic makeup and breed predisposition, dogs and cats form uroliths of specific types for a variety of reasons. There are multiple underlying predisposing causes that can increase stone formation risk in an individual. Although knowing specific RSS values can be helpful for management of this common concern, feeding an RSS-tested diet exclusively is no guarantee that a dog or cat will not form a urolith.

Risk for stone formation or recurrence is much more dependent on urolith type, ongoing patient-monitoring capability, and ability to do a thorough patient and nutritional assessment for contributing risk factors that can be eliminated.^{1,7-22}

Feeding a diet with effective RSS values appears to have an impact on struvite and calcium oxalate urolith management, but this is only 1 of multiple medical and nutritional considerations for these pets.

Benefits & Limitations

Every patient is unique, and myriad factors may contribute to urolithiasis risk. Like any other research diagnostic aid, RSS provides both benefits and limitations. RSS can be used to help prevent stone recurrence and aid dissolution when used properly. Awareness of its limitations must be made clear to clients. As an example, dogs with struvite stones almost always have or have had urinary tract infections (UTIs). Effective dissolution and prevention of struvite uroliths in dogs thus depends on appropriate antibiotic selection, dose, frequency, and duration.

Urinalysis and urine culture and susceptibility testing are indicated in all of these canine urolith patients.

Consequently, urinary diet/RSS plays a much lesser role than appropriate infection therapy. Similarly, ongoing monitoring for infection is key to prevent recurrence of struvite urolithiasis in dogs.

New Methodology

Urolithiasis management is an area of active research among many pet food manufacturers and independent researchers. A new analysis method, calcium oxalate risk index (CORI), has recently been described.²³ CORI is believed to also account for urine crystal inhibitors and promoters in a dog's or cat's urine. Currently there is consensus that RSS is the best method to evaluate urine for urolith risk; however, this may change with additional study. CORI testing, performed together with RSS, may bring much-needed insight into reducing the risk of calcium oxalate urolith formation in pets. This type of combined testing may also provide clinically relevant information that a specific therapy (dietary or drug) aimed at urolith risk reduction is truly reducing risk of calcium oxalate recurrence in an individual patient.

Conclusion

Understanding the RSS results performed on pet foods can provide helpful information for dogs and cats with specific urolith risk and

CORI = calcium oxalate risk index

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for pets requiring medical or nutritional struvite stone dissolution. As with any research methodology used for patient management, an understanding of limitations of RSS determination and awareness that reliance on 1 type of management strategy is unlikely to be successful are key.

Different uroliths require specific management approaches—ideally based on knowledge of stone type(s) and identification of underlying cause(s). Uroliths are managed based on stone composition, and optimum therapy for prevention (nutritionally or otherwise) begins with this information. ■

References

1. Robertson WG, Jones JS, Heaton MA, Stevenson AE, Markwell PJ. Predicting the crystallization potential of urine from cats and dogs with respect to calcium oxalate and magnesium ammonium phosphate (struvite). *J Nutr.* 2002;132(6 Suppl 2):1637S-1641S.
2. Werness P, Brown C, Smith L, Finlayson B. EQUIL2: A basic computer program for the calculation of urinary saturation. *J Urol.* 1985;134(6):1242-1244.
3. Markwell PJ, Smith BHE, McCarthy KP. A non-invasive method for assessing the effect of diet on urinary calcium oxalate and struvite relative super-saturation in the cat. *Anim Tech.* 1999;50(2):61-67.
4. Bartges JW, et al. Comparison of struvite activity product ratios and relative supersaturations in urine collected from healthy cats consuming four struvite management diets. Ralston Purina Nutrition Symposium. St. Louis, MO; 1998.
5. Stevenson AE, Blackburn JM, Markwell PJ, Robertson WG. Nutrient intake and urine composition in calcium oxalate stone-forming dogs: Comparison with healthy dogs and impact of dietary modification. *Vet Ther.* 2004;5(3):218-231.
6. Stevenson AE, Hynds WK, Markwell PJ. Effect of dietary moisture and sodium content on urine composition and calcium oxalate relative supersaturation in healthy miniature schnauzers and Labrador retrievers. *Res Vet Sci.* 2003;74(2):145-151.

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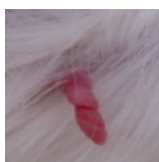
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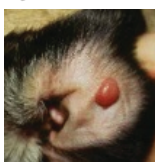
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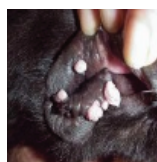
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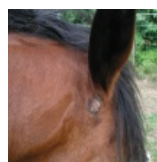
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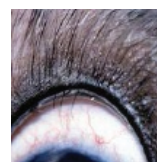
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