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# Microscopic evaluation and Descriptive study of Crystals and Uroliths encountered in the Urinary tract system of Cats and Dogs

## Evaluación microscópica y estudio descriptivo de cristales y urolitos encontrados en el sistema de vías urinarias de perros y gatos

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### ABSTRACT

In this study, the presence and types of urine crystals in cats and dogs with urolithiasis/crystaluria and the effects of some demographic factors (such as type, breed, age, sex, sterilization status) on them were evaluated. In the study, physical, chemical and sediment examinations of urine samples of 67 cats and dogs were performed. It was determined that 83.58% of the animals with crystals in their urine were male. It was determined that 63.64% of the female animals and 44.64% of the male animals with crystals detected in the urinary tract were sterilized. It was determined that urinary crystals were more common in cats between 1-3 years of age (AO) and in dogs older than 3 AO. It was determined that calcium oxalate crystal (64.41%) in cats and struvite crystal (50%) in dogs were the most common crystals. It was determined that urine crystals were found mostly in cross breeds in cats and dogs. It was determined that most of the cats and dogs with urine crystals were fed with home meals and non-branded foods. It was determined that urinary tract infections had an effect on the formation of urine crystals. As a result, it was concluded that it is important in terms of Veterinary Medicine that such studies should be routinely performed, especially in the United States of North America (such as the Minnesota Urolith Center), since urine crystals cause significant lower urinary system diseases.

**Key words:** Calcium oxalate; cat; dog; urolite; struvite

### RESUMEN

En este estudio se evaluó la presencia y tipos de cristales de orina en gatos y perros con urolitiasis/cristaluria y los efectos de algunos factores demográficos (como tipo, raza, edad, sexo, estado de esterilización) sobre ellos. En el estudio se realizaron exámenes físicos, químicos y de sedimentos de muestras de orina de 67 gatos y perros. Se determinó que el 83,58 % de los animales con cristales en la orina eran machos. Se determinó que el 63,64 % de las hembras y el 44,64 % de los machos con cristales detectados en vías urinarias fueron esterilizados. Los cristales urinarios eran más comunes en gatos entre 1-3 años (a) y en perros mayores de 3 a. Se determinó que el cristal de oxalato de calcio (64,41 %) en gatos y el cristal de estruvita (50 %) en perros fueron los cristales más comunes. Los cristales de orina se encontraron principalmente en razas cruzadas en gatos y perros. La mayoría de los gatos y perros con cristales en la orina se alimentaban con comidas caseras y alimentos sin marca. Se determinó que las infecciones del tracto urinario tenían efecto en la formación de cristales en la orina. Como resultado se concluyó que, es importante en términos de Medicina Veterinaria que dichos estudios se realicen de forma rutinaria, especialmente en los Estados Unidos de NorteAmerica (como el Minnesota Urolith Center), ya que los cristales de orina causan enfermedades importantes del sistema urinario inferior.

**Palabras clave:** Oxalato de calcio; gato; perro; urolita; estruvita

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## INTRODUCTION

Crystalluria refers to the presence of crystals in the urine, which occurs due to the oversaturation of certain electrolytes and/or, substances and can cause an important lower urinary tract disease such as urolithiasis. Urolithiasis is one of the important urinary system (US) problems encountered in all animals. Uroliths are formed by the combination of many physiological and pathological factors that cause changes in urine composition. These physiological and pathological factors cause saturation of some substances in the urine and their precipitation in the Urinary System (US) [3, 5, 9, 11, 16, 17, 20, 24, 25].

Anatomical and metabolic abnormalities, US infections, malnutrition and variability in urine pH are very important risk factors for the formation of uroliths. Struvite crystals (SC) mostly occur in young animals, while calcium oxalate crystals (COC) occur mostly in older animals. It is also more common in female cats (*Felis catus*) and dogs (*Canis lupus familiaris)* than males. This shows that factors such as age, sex and breed are effective in the formation of uroliths [3, 4, 16, 20, 23, 24]. Determining the causes of the formation and growth of crystals is very important in preventing urolith formation [3].

The cases of urolithiasis may differ according to the etiology and chemical structure of the formed crystals. SC, COC, cystine (CC) and urate urolites (UC) are the most common urinary crystals in pets [24]. According to the Minnesota Urolith Center, the most common urolite in dogs is SC, while in cats it is COC [3, 16, 20].

SC occurs as a result of crystallization of magnesium, ammonium and phosphate minerals in the US by reaching supersaturation. In cases encountered in dogs, urinary tract infections caused by bacteria producing urease enzyme *(Staphylococcus* spp., *Proteus)* and alkalinity of urine are effective. Dietary, metabolic and genetic factors are mostly effective in the formation of SC in cats [3, 16, 18, 20, 24].

COC is one of the most common urinary tract crystals in cats and dogs [3, 6]. COC are more common in Schnauzer and Lhasa Apso breeds in dogs, and Ragdoll and British Shorthair breeds in cats [6]. COC form as a result of oversaturation of the urine with crystalloids. Hypercalciuria is the most important factor in the formation of COC. Excessive amounts of calcium, protein, sodium, vitamin D and vitamin C in foods are effective in the formation of hypercalciuria. Again, diets and drugs that cause acidification of the urine are effective in the formation of hypercalciuria. Hypercalciuria may also occur in patients with hyperadrenocorticism [4, 6, 7, 24].

UC or purine crystals are the third most common type of crystal in cats and dogs. UC are formed as a result of precipitation of uric acid and uric acid salts (ammonium urate, sodium urate, sodium calcium urate, potassium urate) in the US. It is known that especially Dalmatian dogs and animals with portovascular anomalies are predisposed to UC [3, 22, 24].

CC are rarely encountered in cats and dogs. Although the formation mechanism is not known exactly, the formation of cystinuria due to the decrease in tubular absorption of cystine taken with foods (pork meat, poultry, etc.) creates a predisposition. However, since cystine is an amino acid soluble in alkaline solutions, it is effective in the formation of CC in acidic urine [24].

In this study, physical, chemical and microscopic sediment examination of urine samples taken from cats and dogs suspected of having uroliths and/or crystals in the urinary tract was performed. The ratios of crystals detected in the urinary tract of cats and dogs and their differences according to species, breed, age, sex, and sterilization status were determined. However, in line with the information received from the owners, some factors such as diet and disease status of the animals with crystals in the urinary tract were evaluated. In addition, it was aimed to evaluate the effect of crystal types on the physical and chemical properties of urine.

## MATERIALS AND METHODS

### Ethical approval

This study was conducted in accordance with the principles of the Local Ethics Committee in the framework of the ethics confirmed by the Firat University Animal Experiments Local Ethics Committee (20.01.2022, 2022/2, Document no: 6368).

### Study design and practices

In this study, it was aimed to investigate the effect of species, breed, diet, age and sex on the formation and type of crystals by physical, chemical and sediment examination of urine samples of cats and dogs with suspected urolith and/or crystals in the urinary tract. For the study, urine samples were collected in sterile tubes during natural urination from cats and dogs who had difficulty urinating in the Provinces of Elazig and Balikesir (Turkey). First of all, physical (color and turbidity) and chemical (pH, blood, leukocyte, protein, among others) examinations of urine samples were performed. An urine analysis strip with the brand name *Acon Insight Expert* was used for the chemical examination of the urine samples. After 5 mililiters (5 mL) of urine collected from cats and dogs was centrifuged at 1,500 rpm (252 G) for 5 minutes, sediment examination was performed under the microscope (Olympus CX21LED brand light microscope, Olympus Corporation, Japan), (crystals, erythrocytes, leukocytes, epithelial cells, among others) [3, 16]. During the study, the samples were evaluated by the same researcher twice by blind examination under the *Nikon Eclipse* brand phase microscope (Nikon Corporation, Japan) and the Olympus CX21LED. Conflicting samples were evaluated once again at the end of the study, both under the light microscope and under the phase microscope.

During the study, information was collected about the diet and general health status of cats and dogs with suspected urolith and/or crystalluria. The effect on urolite and/or crystalluria formation was evaluated by comparing the analytical components, nutritional contributions per kilogram (kg) and energy values of commercial foods. Thus, the relationship between crystal types and feeding patterns was also evaluated. Frequencies were calculated using the SPSS package program descriptive statistics.

## RESULTS AND DISCUSSION

In this study, physical, chemical and sediment examinations of urine samples of 67 cats and dogs with crystals detected in the urinary tract were performed (TABLE I).

Animals with crystals in their urine; it was determined that 11.94% were dogs (n=8) and 88.06% were cats (n=59). It was determined that 83.58% of them were male (n=56) and 16.42% were female (n=11). Animals with crystals in their urine; it was determined that 47.76% of them were neutered/castrated (n=32) and 52.24% were not neutered/castrated (n=35). Urine crystals were found to be more common in cats between the ages of 1-3 and in dogs older than 3 AO. The rates

***TABLE I***
**Detailed evaluations of cases with urinary crystals**

| Case # | Species | Breeds | Age | Sex | Neutering Status | Blood | Protein | pH | Density | Crystal type |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Cat | Crossbreed | 3 year | M | + | 2 | 3 | 7.5 | 1.022 | Struvite |
| 2 | Cat | Crossbreed | 6 year | F | + | 3 | 2 | 7 | 1.022 | Struvite |
| 3 | Cat | Crossbreed | 3 year | M | + | 0 | 1 | 6 | 1.022 | Uric Acid - Calcium Oxalate |
| 4 | Cat | Crossbreed | 4 year | M | - | 0 | 3 | 7 | 1.011 | Calcium Oxalate |
| 5 | Cat | Crossbreed | 2 year | M | - | 4 | 4 | 7 | 1.022 | Amorphous Biurate |
| 6 | Cat | Crossbreed | 2 year | M | - | 4 | 3 | 6.5 | 1.033 | Struvite |
| 7 | Cat | Crossbreed | 3 year | F | + | 4 | 3 | 6.5 | 1.033 | Amorphous Biurate - Calcium Oxalate - Uric Acid |
| 8 | Cat | Crossbreed | 3 year | M | + | 4 | 3 | 6 | 1.033 | Cystine- Calcium Oxalate - Uric Acid |
| 9 | Cat | Crossbreed | 3 year | M | - | 3 | 4 | 7 | 1.033 | Calcium Oxalate- Struvite |
| 10 | Cat | Crossbreed | 2 year | F | - | 4 | 2 | 6 | 1.033 | Uric Acid |
| 11 | Cat | Crossbreed | 5 year | M | - | 2 | 4 | 7.5 | 1.011 | Calcium Oxalate |
| 12 | Cat | Crossbreed | 3 year | M | - | 1 | 2 | 7 | 1.011 | Struvite |
| 13 | Cat | Crossbreed | 2 year | M | - | 4 | 4 | 9 | 1.011 | Struvite |
| 14 | Dog | Bernese Mountain | 8 year | F | + | 1 | 0 | 6.5 | 1.011 | Struvite |
| 15 | Dog | Crossbreed | 6 year | M | - | 4 | 1 | 7 | 1.022 | Calcium Phosphate |
| 16 | Cat | Crossbreed | 1 year | F | - | 0 | 1 | 6.5 | 1.022 | Cystine - Uric Acid |
| 17 | Dog | Shih Tzu | 3 year | M | + | 1 | 0 | 7 | 1.011 | Struvite |
| 18 | Cat | British | 3 year | M | - | 3 | 3 | 8.5 | 1.022 | Struvite - Calcium Oxalate |
| 19 | Cat | Scottish | 2 year | M | - | 4 | 2 | 7 | 1.022 | Struvite |
| 20 | Cat | Crossbreed | 4 year | M | - | 4 | 3 | 7 | 1.011 | Calcium Oxalate |
| 21 | Cat | Crossbreed | 2 year | F | - | 1 | 2 | 7 | 1.022 | Calcium Oxalate - Amorphous Biurate |
| 22 | Cat | Crossbreed | 4 year | M | - | 2 | 3 | 7.5 | 1.011 | Calcium Oxalate |
| 23 | Cat | Crossbreed | 12 year | M | + | 4 | 0 | 6.5 | 1.033 | Struvite |
| 24 | Cat | British | 1 year | M | - | 4 | 2 | 7.5 | 1.022 | Struvite |
| 25 | Cat | Crossbreed | 7 year | M | + | 4 | 2 | 7.5 | 1.022 | Struvite - Hippuric Acid |
| 26 | Cat | Crossbreed | 4 year | M | + | 3 | 3 | 7.5 | 1.011 | Calcium Oxalate - Calcium Phosphate |
| 27 | Cat | Crossbreed | 7 year | M | + | 4 | 3 | 6 | 1.033 | Cystine - Calcium Oxalate |
| 28 | Cat | Scottish | 2 year | M | + | 4 | 0 | 7 | 1.044 | Calcium Oxalate |
| 29 | Cat | Crossbreed | 1 year | M | - | 0 | 3 | 7 | 1.011 | Calcium Oxalate |
| 30 | Cat | Crossbreed | 1 year | M | - | 4 | 3 | 7 | 1.022 | Struvite - Calcium Oxalate |
| 31 | Cat | Crossbreed | 4 year | M | + | 0 | 2 | 7.5 | 1.022 | Calcium Oxalate |
| 32 | Cat | Crossbreed | 2 year | M | + | 2 | 1 | 6.5 | 1.011 | Calcium Phosphate |
| 33 | Cat | Crossbreed | 3 year | F | + | 2 | 2 | 7.5 | 1.033 | Calcium Phosphate - Struvite |
| 34 | Dog | Pomerian | 6 year | F | - | 0 | 1 | 9 | 1.011 | Struvite |
| 35 | Cat | British | 2 year | M | + | 1 | 2 | 8.5 | 1.022 | Calcium Carbonate |
| 36 | Dog | Crossbreed | 6 month | M | - | 2 | 2 | 6 | 1.022 | Urate – Cystine |
| 37 | Dog | Jack Russel | 7 year | M | - | 0 | 1 | 7 | 1.033 | Calcium Oxalate |
| 38 | Cat | Scottish | 2 year | M | - | 4 | 3 | 7.5 | 1.022 | Struvite |
| 39 | Cat | Crossbreed | 3 year | M | + | 0 | 2 | 8 | 1.022 | Struvite - Calcium Oxalate – Calcium Phosphate |
| 40 | Cat | Scottish | 2 year | M | - | 0 | 2 | 7 | 1.033 | Calcium Oxalate |
| 41 | Cat | Crossbreed | 2 year | F | + | 0 | 2 | 8 | 1.022 | Calcium Oxalate - Calcium Phosphate |
| 42 | Cat | Crossbreed | 3 year | M | - | 3 | 4 | 8.5 | 1.011 | Calcium Phosphate - Struvite |
| 43 | Cat | Smokin | 3 year | M | + | 4 | 3 | 7 | 1.011 | Calcium Oxalate - Acyclovir |

***TABLE I* cont...**
**Detailed evaluations of cases with urinary crystals**

| Case # | Species | Breeds | Age | Sex | Neutering Status | Blood | Protein | pH | Density | Crystal type |
|---|---|---|---|---|---|---|---|---|---|---|
| 44 | Cat | Crossbreed | 3 year | M | + | 4 | 1 | 5 | 1.033 | Calcium Oxalate - Urate - Uric Acid |
| 45 | Cat | Persian | 4 year | M | + | 0 | 2 | 7 | 1.033 | Calcium Oxalate |
| 46 | Cat | Persian | 3 year | M | + | 0 | 3 | 8 | 1.022 | Calcium Phosphate - Calcium Oxalate |
| 47 | Cat | Crossbreed | 2 year | M | - | 0 | 0 | 5 | 1.022 | Uric Acid - Calcium Oxalate |
| 48 | Cat | Crossbreed | 2 year | M | + | 0 | 2 | 8 | 1.033 | Calcium Oxalate - Struvite – Calcium Carbonate |
| 49 | Cat | Crossbreed | 4 month | M | - | 4 | 3 | 5.5 | 1.033 | Urate - Uric Acid - Cystine |
| 50 | Dog | Charles Cavalier | 11 year | M | + | 2 | 1 | 6 | 1.022 | Calcium Oxalate |
| 51 | Cat | British | 2 year | M | - | 4 | 2 | 6 | 1.033 | Calcium Oxalate - Uric Acid - Cystine |
| 52 | Cat | Crossbreed | 4 year | M | + | 4 | 3 | 6 | 1.033 | Calcium Oxalate - Calcium Sulfate |
| 53 | Cat | Crossbreed | 2 year | M | + | 4 | 2 | 7 | 1.022 | Calcium Oxalate - Uric Acid |
| 54 | Cat | Scottish | 2 year | M | + | 1 | 1 | 7 | 1.022 | Calcium Oxalate - Struvite |
| 55 | Cat | Persian | 2 year | M | + | 0 | 2 | 8.5 | 1.011 | Amorphous Biurate - Calcium Oxalate - Struvite |
| 56 | Cat | Crossbreed | 2 year | M | - | 1 | 3 | 8 | 1.022 | Calcium Oxalate |
| 57 | Cat | Crossbreed | 2 year | M | - | 2 | 2 | 6.5 | 1.022 | Calcium Oxalate - Cystine |
| 58 | Cat | Crossbreed | 3 year | M | - | 2 | 3 | 8 | 1.022 | Calcium Oxalate - Struvite – Calcium Phosphate |
| 59 | Cat | Crossbreed | 2 year | M | - | 0 | 3 | 7 | 1.022 | Amorphous Biurate - Calcium Oxalate |
| 60 | Cat | British | 4 year | M | - | 3 | 3 | 8.5 | 1.011 | Calcium Carbonate |
| 61 | Cat | Persian | 2 year | M | + | 0 | 3 | 8 | 1.033 | Calcium Oxalate - Struvite |
| 62 | Cat | Crossbreed | 2 year | M | + | 0 | 2 | 7.5 | 1.022 | Calcium Oxalate - Struvite – Calcium Phosphate |
| 63 | Cat | Crossbreed | 2 year | M | - | 0 | 2 | 8 | 1.022 | Calcium Oxalate - Struvite |
| 64 | Cat | Crossbreed | 3 year | M | - | 1 | 0 | 6 | 1.022 | Urate - Uric Acid |
| 65 | Cat | Crossbreed | 4 year | F | + | 1 | 0 | 6 | 1.011 | Uric Acid - Cystine - Calcium Oxalate |
| 66 | Cat | Crossbreed | 2 year | M | - | 2 | 0 | 5.5 | 1.022 | Uric Acid - Cystine |
| 67 | Dog | Pomerian | 4 year | F | + | 0 | 0 | 7 | 1.022 | Struvite |

according to sex, neutered/castrated status and age of animals with crystals in their urine are presented in the tables (TABLE II, III and IV).

It was determined that 74.57% of cats and 25% of dogs with crystals detected in the urinary tract were crossbreeds. The distribution of the animals with urine crystals according to breeds was presented in FIG 1.

In the study, 11 different crystal types were found in 67 animals with crystals in their urine (FIGS. 2 and 3). While a single crystal type was detected in the urine of 31 (46.27%) of these animals, it

***TABLE II***
**Ratios of animals with urine crystals detected by sex**

| Sex | Dog | | Cat | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Female | 3 | 37.5 | 8 | 13.56 | 11 | 16.42 |
| Male | 5 | 62.5 | 51 | 86.44 | 56 | 83.58 |

***TABLE III***
**Ratios of animals with urine crystal detection according to neutering status**

| Neutering Status | Dog | | | | Cat | | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Female | | Male | | Female | | Male | | Female | | Male | |
| | n | % | n | % | n | % | n | % | n | % | n | % |
| Neutered | 2 | 66.67 | 2 | 4 | 5 | 62.5 | 23 | 45.10 | 7 | 63.64 | 25 | 44.64 |
| Not neutered | 1 | 33.33 | 3 | 60 | 3 | 37.5 | 28 | 54.90 | 4 | 36.36 | 31 | 55.36 |
| Total | 3 | 100 | 5 | 100 | 8 | 100 | 51 | 100 | 11 | 100 | 56 | 100 |

***TABLE IV***
**Ratios of animals with urine crystals detected by age ranges**

| Age | Dog | | Cat | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| 0–1 age | 1 | 12.5 | 5 | 8.47 | 6 | 8.96 |
| 1–3 age | 1 | 12.5 | 40 | 67.80 | 41 | 61.19 |
| Over 3 years old | 6 | 75 | 14 | 23.73 | 20 | 29.85 |

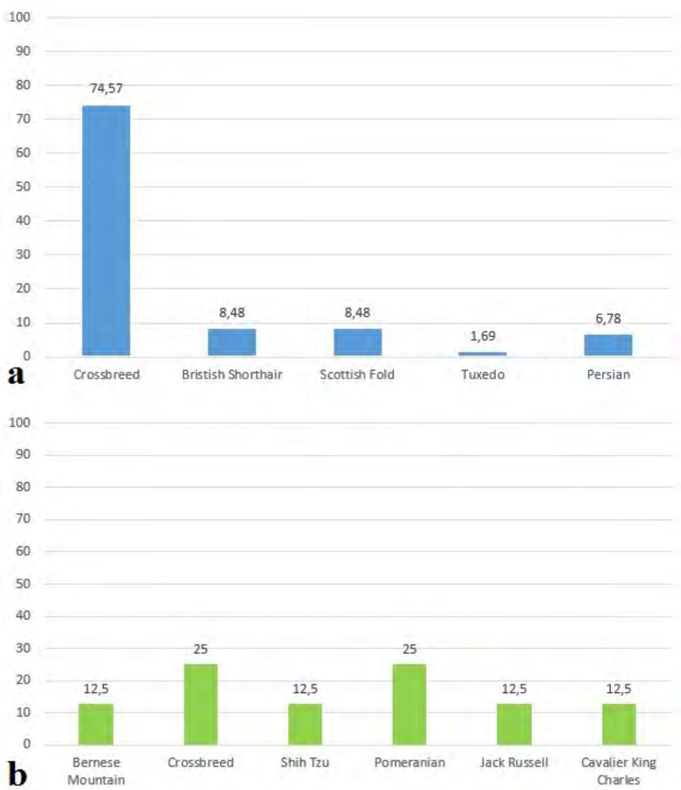


**FIGURE 1. Distribution of cats (a) and dogs (b) with crystals in their urine according to breeds**

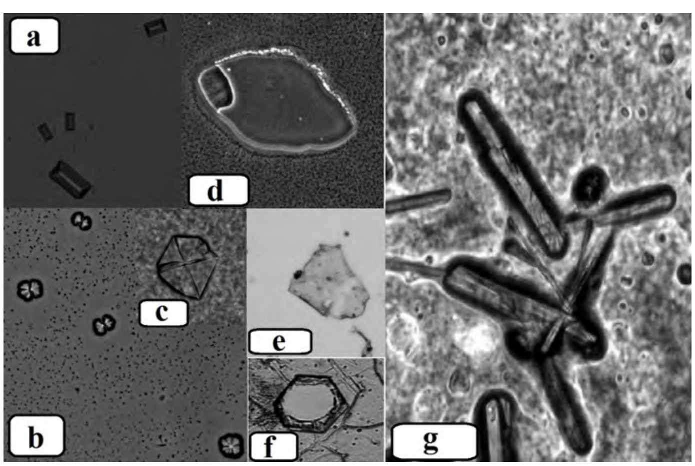


**FIGURE 2. Phase microscope images of some urine crystals detected in the study, Struvite (a), Calcium oxalate (b,c), Uric acid (d), Calcium carbonate (e), Cystine (f), Calcium phosphate**

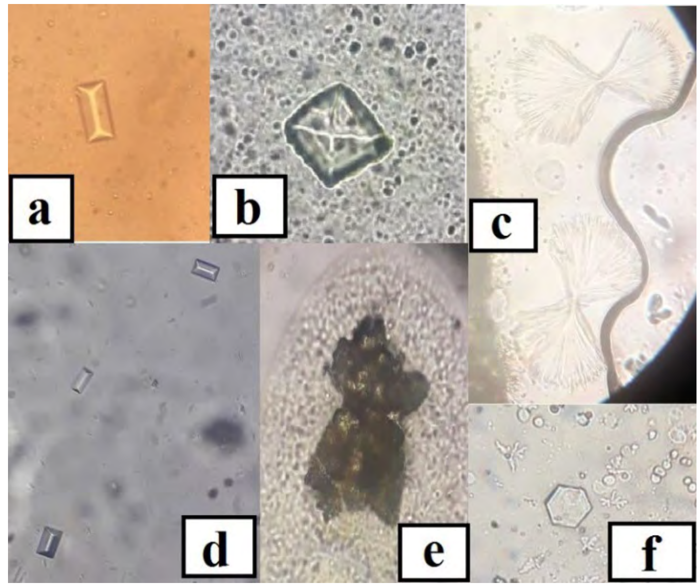


**FIGURE 3. Light microscope images of some urine crystals detected in the study, Struvite (a, d), Calcium oxalate (b), Acyclovir (c), Amorphous biurate (e), Cystine (f)**

was determined that there was more than one crystal type in the urine of 36 (53.73%) animals. COC were found in 64.61% (n=38) of the cats with crystals in their urine. SC were detected in 50% (n=4) of the dogs. The detection rates of urine crystals in animals and their distribution according to animal species were presented in TABLE V. The distribution of the types of urine crystals by sex was presented in TABLE VI.

In this study, it was determined that cats and dogs with crystals in their urine were mostly cross-breeds. Histogram graphs showing the distribution of urine crystals found in purebred breeds of cats and dogs in the study are presented in FIG. 4.

***TABLE V***
**Detection rates of urine crystals in animals and distribution by animal species**

| Crystal type | Cat | | Dog | | Total (Cat-Dog) | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Struvite | 23 | 38.98 | 4 | 50.0 | 27 | 40.30 |
| Calcium oxalate | 38 | 64.41 | 2 | 25.0 | 40 | 59.70 |
| Uric acid | 13 | 22.03 | - | - | 13 | 19.40 |
| Cystine | 8 | 13.56 | 1 | 12.50 | 9 | 13.43 |
| Calcium phosphate | 9 | 15.25 | 1 | 12.50 | 10 | 14.93 |
| Amorphous biurate | 5 | 8.47 | - | - | 5 | 7.46 |
| Urate | 3 | 5.08 | 1 | 12.50 | 4 | 5.97 |
| Calcium carbonate | 3 | 5.08 | - | - | 3 | 4.48 |
| Hippuric acid | 1 | 1.70 | - | - | 1 | 1.49 |
| Acyclovir | 1 | 1.70 | - | - | 1 | 1.49 |
| Calcium sulfate | 1 | 1.70 | - | - | 1 | 1.49 |

***TABLE VI***
**The distribution of the types of urine crystals by sex**

| Crystal type | Female | | Male | | Total | |
|---|---|---|---|---|---|---|
| | n | % | n | % | n | % |
| Struvite | 5 | 18.52 | 22 | 81.48 | 27 | 100 |
| Calcium oxalate | 4 | 10.00 | 36 | 90.00 | 40 | 100 |
| Uric acid | 4 | 30.77 | 9 | 69.23 | 13 | 100 |
| Cystine | 2 | 22.22 | 7 | 78.78 | 9 | 100 |
| Amorphous biurate | 2 | 40.00 | 3 | 60.00 | 5 | 100 |
| Calcium phosphate | 2 | 20.00 | 8 | 80.00 | 10 | 100 |
| Urate | - | - | 4 | 100 | 4 | 100 |
| Calcium carbonate | - | - | 3 | 100 | 3 | 100 |
| Hippuric acid | - | - | 1 | 100 | 1 | 100 |
| Acyclovir | - | - | 1 | 100 | 1 | 100 |
| Calcium sulfate | - | - | 1 | 100 | 1 | 100 |

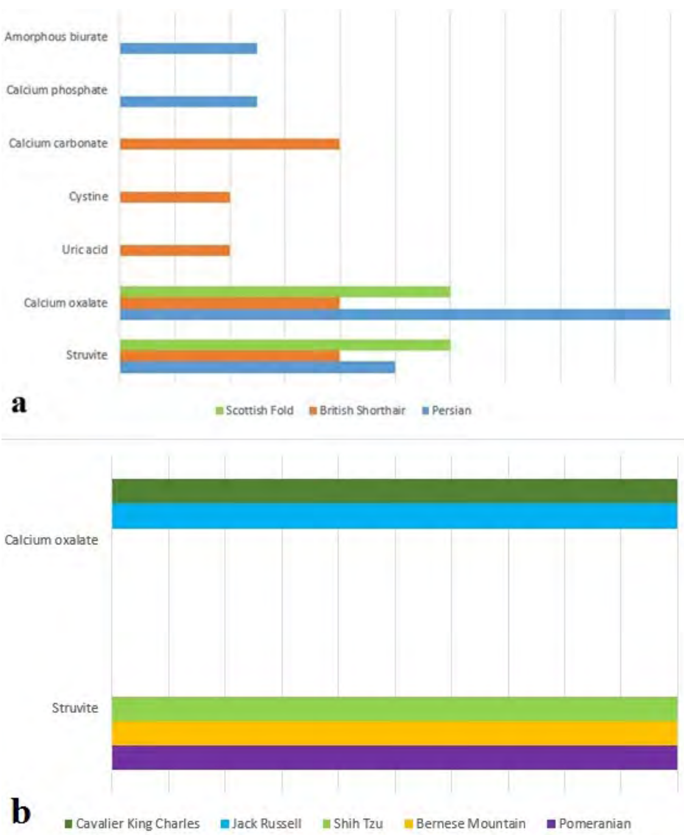


**FIGURE 4. Histogram graphs of the crystal types encountered in purebred cat (a) and dog (b) breeds with crystals in the urinary tract**

Animals with crystals in their urinary tract; it was determined that 47.76% of them (n=32) were fed with home-made and unbranded foods, 22.38% of them (n=15) were fed with foods containing 34-38% crude protein, 20.90% of them (n=14) were fed with foods containing 40-44% of crude protein, and 8.96% of them (n=6) were fed with foods containing 29-32% of crude protein. Cats with SC; it was determined that 43.48% of them (n=10) were fed with home meals and unbranded cat food, 34.78% of them (n=8) were fed with cat foods containing 36-42% crude protein, and 21.74% of them (n=5) were fed with cat foods containing 29-32% of crude protein. It was determined that all of the dogs with SC were fed with dog foods containing 42-44% crude protein. Cats with COC; it was determined that 44.74% (n=17) were fed with home meals and unbranded cat food, 31.58% (n=12) with cat food containing 36-44% crude protein, and 23.68% (n=9) with cat food containing 29-32% crude protein.

Urinary tract infections were found in 59.70% (n=40) of the animals with crystals in the urinary tract. Urinary tract infections were found in 70.37% of the animals (n=19) with SC. It was determined that this rate was 73.91% in cats (n=17) and 50% in dogs (n=2). Urinary tract infection was detected in 65.79% of the cats (n=25) in which COC was detected. No urinary tract infection was detected in any of the two dogs with COC.

Many physiological and pathological factors cause changes in urine composition and cause the accumulation of crystals in the urine (crystaluria). In patients who develop crystalluria, serious lower US problems such as urolithiasis may develop in the future [1, 3, 16, 19, 20, 24, 25]. Some demographic factors such as animal species, breed, age, and sex may have an effect on crystalluria/urolithiasis formation and crystal type [3, 4, 16, 20, 24]. In this study, physical, chemical and sediment examinations of the urine of animals with suspected crystalluria/urolithiasis were performed. It was aimed to determine the distribution of crystals according to types, the effect of demographic factors on crystal formation, and the factors affecting its etiology (such as nutrition, urinary tract infections) in 67 animals (59 cats, 8 dogs) with crystals in the urinary tract during examinations.

Some studies [8, 21] have reported that dogs develop more crystalluria urolithiasis than cats. Houston *et al.* [8], in their study conducted at the Canadian Veterinary Urolith Center between 1998 and 2008, reported that 78% of the animals with uroliths were dogs. Sancak *et al.* [21], reported that 11 of the 15 animals brought to Ankara University Veterinary Faculty, between 2002-2003 and treated for uroliths were dogs. In this study, contrary to similar ones, it was, it was determined that more crystalluria/urolithiasis occurred in cats (88.06%) than in dogs.

It has been reported that the incidence of crystalluria/urolithiasis is higher in females in some studies [8, 12, 15, 24] and in males in some studies [21]. In this study, it was determined that the incidence of crystalluria was higher in males (83.58%). It was determined that 86.44% of cats and 62.5% of dogs with crystalluria were male. In many studies [3, 8, 10, 12, 14, 15], it has been reported that SC are more common in female cats and dogs, and COC are more common in male cats and dogs. In this study, unlike other studies, SC were more common in male cats than in female cats. However, it was determined that the incidence of SC in dogs was higher in females than in males. It was determined that the incidence of COC and other crystal types was higher in both male cats and male dogs.

It is known that neutered/castrated has an effect on the formation of some urine crystals [6, 12, 13]. Gisselman *et al.* [6], reported an increased incidence of COC in neutered cats and dogs. Kopecny *et al.* [12], in their study on 10,444 dogs, reported that 74.2% of male dogs with COC and 84.3% of male dogs with UC were castrated. In this study, it was determined that 63.64% of female cats and dogs with crystalluria were neutered. It was determined that 44.64% of male cats and dogs with crystalluria had a castration operation. In addition, the fact that 52.78% of male cats and dogs with COC were castrated in this study is important in terms of supporting other studies.

One of the demographic factors affecting the formation of urine crystals is age. SC mostly occur in young animals, while COC occur mostly in older animals [3, 10, 12, 14, 16, 20]. Kopecny *et al*. [12], in their study on 10,444 dogs, reported that the incidence of COC was 60% among dogs aged 7 years and older, and 57.6% of SC among dogs younger than 7 AO. Langston *et al*. [14], on the other hand, reported that the incidence of SC was higher in cats younger than four AO, and COC were more common in cats older than seven AO. In this study, it was determined that urine crystals were mostly seen in cats aged 1-3 (67.8%) and dogs older than 3 years (75%). In this study, similar to other studies, it was determined that SC were mostly seen in young animals (77.78% in animals three years and younger). However, contrary to other studies, it was determined that COC were mostly seen in young animals (70% in animals three years and younger).

There are many studies reporting that cats and dogs are predisposed to breed in the formation of different urine crystals [1, 2, 6, 8, 15]. Houston *et al*. [8], in their study between 1998 and 2008, reported that the risk of urolithiasis is high in dog breeds such as cross breeds, Miniature schnauzer, Shih tzu, Lhasa apso, Bichon Frize and Yorkshire Terrier. In cats, they reported that the risk of urolithiasis is high in breeds such as domestic shorthair, domestic longhair, domestic mediumhair, Himalayan, Persian, and Ragdoll. Albasan *et al*. [2], reported that the risk of urolithiasis is high in cross breeds in cats and Miniature schnauzer and Shih tzu breeds in dogs. In this study, urine crystals were detected the most in cross breeds in both cats (74.57%) and dogs (25%). Twenty five percent of the of the urine crystals in dogs were also detected in the Pomeranian breed.

Urine crystals can differ according to their chemical structure. SC, COC, CC and UC are the most common urine crystals in pets [24]. According to the Minnesota Urolith Center, the most common urolite in dogs is SC, while in cats COC [3, 16, 20]. In the study of Houston *et al*.[8], urolith cases detected in cats; it was determined that 48.93% were COC and 43.30% were SC. In the same study, urolith cases detected in dogs; it was determined that 45.24% had COC and 38.77% had SC. Albasan *et al*. [2] in their study, detected in cats urolith cases; it was determined that 53.96% were COC and 41.06% were SC. In this study, the cats with urine crystals detected; SC were detected in 38.98% and COC in 64.41%. Of the dogs with urine crystals, SC were detected in 50% and COC in 25%. Uric acid (22.03%), CC (13.56%) and calcium phosphate (15.25%) crystals were detected in a significant portion of the cats with urine crystals.

Nutrition is a very important factor in the formation of crystalluria/urolithiasis in cats and dogs. Commercial foods containing high amounts of vegetables and grain feeds (high potassium cations) that make the urine alkaline cause the formation of SC. In cats and dogs fed with diets containing high amounts of animal protein, the acidity of the urine increases due to protein catabolism. In this case, COC and uroliths are formed [13]. In this study, it was determined that most of the cats (65.22%) with SC were fed with low protein foods and home meals. It was determined that dogs with SC were fed commercial foods containing high protein but mainly vegetable protein. Again, in this study, it was determined that only 31.58% of cats and dogs with COC were fed commercial foods with high protein content.

It has been reported that the incidence of urinary tract infection is high in animals with crystalluria/urolithiasis [3, 21]. In this study, urinary tract infection was determined in 59.70% of the animals with urinary crystals. While this rate was 65.79% in animals with COC, it was 70.37% in animals with struvite crystals. In the study of Albasan *et al*. [3], it was reported that 95% of dogs and 10% of cats with SC were found to have urinary tract infections caused by proteus and staphylococcus. In this study, urinary tract infections were detected in 73.91% of cats and 50% of dogs with SC.

## CONCLUSION

As a result, although the effect of demographic factors such as species, breed, age and sex on the formation of urinary crystals was similar in many studies, there were also differences. Urine crystals were found to be higher in cats than in dogs, and in male animals than in females. Urine crystals were found to be more common in cats at young ages and in dogs at older ages. The most common urinary crystal in cats was COC, while in dogs it was SC. It was determined that sterilization significantly increased the risk of urinary crystals in female cats and dogs. However, it showed that neutering had no significant effect on the risk of urinary crystals in male cats and dogs. In this study, it was determined that urine crystals were more common in cats and dogs fed with poor quality and home food. In addition, it was determined that urinary tract infection increased the risk of urinary crystal formation.

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### Ethical statement

This study was approved by the Firat University Animal Experiments Local Ethics Committee (20.01.2022, 2022/2, Document no: 6368).

### Conflict of interest

The authors declared that there is no conflict of interest.

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