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EFFECTS OF THERAPEUTIC PET FOOD (URINARY CARE) ON WEIGHT, BODY CONDITION SCORE, URINE PROFILE, FECAL SCORE AND BLOOD PROFILE IN HEALTHY CATS

by

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(D21A0123)

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ABSTRACT

An abstract of the research paper presented to the Faculty of Veterinary Medicine, Universiti Malaysia Kelantan, in partial requirement of the course DVT 55204 - Research Project.

Lower urinary tract disease is common in the feline population, with struvite crystalluria being the main cause. Nutritional management is a cornerstone of prevention, which helps to modify the urinary environment and maintain overall health. This study evaluated the efficacy of a Therapeutic Urinary Care Feed in maintaining systemic health by maintaining normal body condition score, body weight and fecal score. It also evaluated the efficacy of a Therapeutic Urinary Care Feed in maintaining normal blood parameters, hematological and serum biochemistry, and promoting a healthy urinary environment in healthy cats based on urine pH, urine specific gravity and urine cytology over a 5-week period. Six healthy castrated male cats participated in a 5-week feed trial. Body weight, body condition score (BCS), fecal score, complete blood count, serum biochemistry (BUN, creatinine), urine pH, urine specific gravity (USG), and urine cytology were measured at baseline and post-intervention. Data were analyzed using paired-sample t-tests and McNemar's test in SPSS, with significance set at $p < 0.05$. The feed maintained BCS and ideal fecal scores in all cats, with no variability from baseline. Body weight remained stable with no significant change ($p = 0.06$). All hematological and biochemical parameters, including BUN and creatinine, remained within normal limits, confirming systemic safety. The USG parameter was significantly increased ($p = 0.00$) and all resolution of struvite crystals in 100% of affected cats ($p = 0.03$). The Therapeutic Urinary Care Feed effectively maintained overall health, demonstrated a strong safety profile, and significantly improved key urinary parameters, leading to the dissolution of struvite crystals. These results support its use as a safe and effective nutritional strategy for promoting urinary tract health in cats. However, further studies are needed to refine feline urinary tract disease prevention protocols, and to study the recurrence rate with relation to cats with diagnosed lower urinary tract diseases.

Keywords: Feline, Therapeutic Urinary Care Feed, Struvite crystals, Body Condition Score, Nutritional Management.

ABSTRAK

Abstrak kertas penyelidikan yang dikemukakan kepada Fakulti Perubatan Veterinar, Universiti Malaysia Kelantan, sebagai sebahagian daripada keperluan kursus DVT 55204 - Projek Penyelidikan.

Penyakit saluran kencing bawah adalah lazim dalam populasi kucing, dengan kristaluria struvit menjadi penyebab utama. Pengurusan pemakanan merupakan tunjang pencegahan, yang membantu mengubah persekitaran urin dan mengekalkan kesihatan menyeluruh. Kajian ini menilai keberkesanan Makanan Penjagaan Urin Terapeutik dalam mengekalkan kesihatan sistemik dengan mengekalkan skor keadaan badan, berat badan dan skor najis yang normal. Kajian ini juga menilai keberkesanannya dalam mengekalkan parameter darah yang normal (hematologi dan biokimia serum), serta mempromosikan persekitaran urin yang sihat dalam kucing sihat berdasarkan pH air kencing, graviti tentu air kencing dan sitologi air kencing sepanjang tempoh 5 minggu. Enam ekor kucing jantan terbuang yang sihat menyertai ujian pemakanan selama 5 minggu. Berat badan, skor keadaan badan (BCS), skor najis, jumlah darah lengkap, biokimia serum (BUN, kreatinina), pH air kencing, graviti tentu air kencing (USG), dan sitologi air kencing diukur pada garis dasar dan selepas intervensi. Data dianalisis menggunakan ujian-t sampel berpasangan dan ujian McNemar dalam SPSS, dengan kepentingan ditetapkan pada $p < 0.05$. Makanan tersebut mengekalkan BCS dan skor najis yang ideal pada semua kucing, tanpa variasi daripada garis dasar. Berat badan kekal stabil tanpa perubahan yang signifikan ($p = 0.06$). Semua parameter hematologi dan biokimia, termasuk BUN dan kreatinina, kekal dalam lingkungan normal, mengesahkan keselamatan sistemik. Parameter USG meningkat secara signifikan ($p = 0.00$) dan terdapat resolusi kristal struvit dalam 100% kucing yang terjejas ($p = 0.03$). Makanan Penjagaan Urin Terapeutik berkesan dalam mengekalkan kesihatan menyeluruh, menunjukkan profil keselamatan yang kukuh, serta meningkatkan parameter urin utama dengan signifikan, seterusnya membawa kepada pembubaran kristal struvit. Hasil ini menyokong penggunaannya sebagai strategi pemakanan yang selamat dan berkesan untuk mempromosikan kesihatan saluran kencing dalam kucing. Walau bagaimanapun, kajian lanjut diperlukan untuk memperhalusi protokol pencegahan penyakit saluran kencing kucing, dan

untuk mengkaji kadar berulang berkaitan dengan kucing yang didiagnosis dengan penyakit saluran kencing bawah.

Kata kunci: Kucing, Makanan Terapeutik Penjagaan Urin, Kristal Struvite, Skor Keadaan Badan, Pengurusan Pemakanan.

CERTIFICATION

This is to certify that we have read this research paper entitled "Effects of Therapeutic Pet Food (Urinary Care) on Weight, Body Condition Score, Urine Profile, Fecal Score and Blood Profile in Healthy Cats" by Natalia Binti Zainal Abidin Shah, and in our opinion it is satisfactory in terms of scope, quality and presentation as partial fulfillment of the requirement for the course DVT 55204- Research Project.

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LIST OF ABBREVIATIONS

FLUTD	**Feline Lower Urinary Tract Disease**
BCS	**Body Condition Score**
kg	**Kilogram**
g	**Gram**
HGB	**Hemoglobin**
HCT	**Hematocrit**
RBC	**Red Blood Cells**
WBC	**White Blood Cells**
PLT	**Platelet**
BUN	**Blood Urea Nitrogen**
CREA	**Creatinine**
p-value	**Sig.**
ME	**Metabolizable Energy**
DER	**Daily Energy Requirement**
RER	**Resting Energy Requiremen**

CHAPTER 1

1.0 INTRODUCTION

Urinary tract health is emerging as a critical concern in feline medicine, with conditions such as struvite urolithiasis and feline idiopathic cystitis (FIC) affecting up to 5% of cats (Lekcharoensuk et al., 2001; Piyarungsri et al., 2020). As awareness of these conditions grows among pet owners and veterinary professionals, therapeutic urinary care diets are gaining prominence in the pet food market. These diets are specially formulated to regulate urine pH, dilute mineral concentration, and prevent crystal formation, thereby reducing the risk of urolithiasis and other urinary disorders (Houston et al., 2004; Lulich et al., 2013). Despite their widespread use, the long-term effects of therapeutic urinary diets on healthy cats remain poorly understood. Most existing research has focused on cats already diagnosed with urinary tract diseases (e.g., urolithiasis or FIC), leaving a gap in knowledge regarding their prophylactic benefits in healthy felines (Buffington et al., 2006; Dorsch et al., 2014).

This study aims to evaluate the holistic impact of therapeutic urinary diets in healthy cats, based on body weight, body condition score (BCS), urine profile, fecal score, and blood parameters in healthy cats, using both quantitative and qualitative assessments. This research will provide novel insights into the prophylactic use of urinary care diets in healthy cats.

1.1 RESEARCH PROBLEM STATEMENT

The high prevalence of urinary tract issues and weight management challenges in cats necessitates effective nutritional interventions to support overall feline health. Therapeutic pet foods designed for urinary care aim to regulate mineral balance and maintain optimal urinary pH, thereby promoting a healthy urinary environment and reducing the risk of urinary tract disorders. However, the effects of such specialized diets on other critical health parameters, including body weight, body condition score, urine profile, fecal quality, and blood biochemical markers in healthy cats, remain inadequately explored. Understanding these effects is essential to ensure that urinary care diets not only support urinary health but also maintain or improve general physiological status without adverse impacts. This research seeks to evaluate the comprehensive impact of a therapeutic urinary care diet on these health indicators in healthy cats, providing evidence-based insights for veterinarians and pet owners regarding the holistic benefits and safety of such dietary interventions.

1.2 RESEARCH QUESTIONS

- Can the consumption of therapeutic urinary care feed maintain the healthy body weight, fecal score and body condition score of cats after 5 weeks of consumption of therapeutic urinary care feed?
- Can the blood profile remain within the normal range of healthy cats fed with therapeutic urinary care feed compared to being on commercial diets?
- Is there significant association between urine cytological findings and urine pH of healthy cats and consumption of therapeutic urinary care feed?

1.3 RESEARCH HYPOTHESIS

1. Null hypothesis: The consumption of therapeutic urinary care feed does not maintain the body weight and body condition score of healthy cats over a period of 5 weeks.
   Alternative hypothesis : The consumption of therapeutic urinary care feed maintains the body weight and body condition score of healthy cats over a period of 5 weeks.

2. Null hypothesis: The blood profile of healthy cats fed with therapeutic urinary care feed does not remain within the normal range

   Alternative hypothesis: The blood profile of healthy cats fed with therapeutic urinary care feed remain within the normal range.
3. Null hypothesis: There is no significant association between urine cytology and urine pH of healthy cats and consumption of therapeutic urinary care feed.
4. Alternative hypothesis: There is a significant association between urine cytology and urine pH of healthy cats and consumption of therapeutic urinary care feed.

1.4 RESEARCH OBJECTIVES

1. To evaluate the effect of therapeutic pet food (urinary care) on the body weight, body condition score, fecal score, urine cytology, urine pH and blood profile of healthy cats.
2. To evaluate the acceptability and palatability of preference of healthy cats toward Therapeutic Urinary Care Feed.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 NUTRITIONAL MANAGEMENT OF FELINE LOWER URINARY TRACT DISEASE (FLUTD)

Feline Lower Urinary Tract Disease (FLUTD) is a common and multifactorial condition affecting cats, with significant implications for their health and well-being. The primary causes include feline idiopathic cystitis (FIC), urolithiasis (struvite and calcium oxalate stones), and urethral plugs. Nutritional management has emerged as a cornerstone in both treatment and prevention, with specialized diets demonstrating efficacy in reducing clinical signs, dissolving uroliths and preventing recurrence. FLUTD accounts for a substantial proportion of feline veterinary visits, with FIC responsible for ~60% of cases, followed by urolithiasis (20–30%) (Forrester et al., 2015). Key clinical signs include dysuria, hematuria, periuria, and stranguria, often leading to urethral obstruction in male cats, a life-threatening emergency (Kruger et al., 1991). Inappropriate elimination due to FLUTD is also a leading cause of cat relinquishment to shelters (Salman et al., 1998), highlighting the need for effective management strategies. Dissolution and prevention of struvite uroliths are analysed by the efficacy of nutritional dissolution. Per ACVIM guidelines, nutritional dissolution is the standard of care for struvite uroliths (Lulich et al., 2016). Clinical trials show rapid dissolution with Hill's c/d Multicare. It dissolves struvite stones in 7–52 days (mean: 27 days), with 50% reduction in size within 2 weeks (Lulich et al.,2013).

2.2 ROLE OF URINARY CARE DIET FORMULA

The primary purpose of a urinary care diet is to prevent Lower Urinary Tract Syndrome (LUTS) by encouraging the production of large volumes of dilute urine. This is achieved by providing higher protein levels, which increase water intake and urine output through enhanced nitrogen excretion. Additionally, a moderate amount of sodium chloride (4.6% on a dry matter basis) can elevate water consumption to around 250 mL per day, compared to only 130 mL per day in salt-free diets. A balanced potential renal solute load (PRSL), consisting of nitrogen, sodium, chloride, phosphorus, and potassium, promotes osmotic diuresis.

Another key function of urinary care diets is to modify urine composition to reduce the risk of urolith formation. This involves carefully regulating mineral content and urine pH. Magnesium levels are maintained between 0.07% and 0.14% DM to inhibit calcium oxalate crystals, while calcium (0.6–1.0% DM) and phosphorus (0.5–0.9% DM) are balanced to prevent mineral imbalances that could encourage stone development. Urine pH is controlled using acidifying agents such as DL-methionine and phosphoric acid to prevent struvite stones by maintaining pH below 6.6, whereas alkalinizing substances like potassium citrate help prevent calcium oxalate stones by keeping pH between 6.8 and 7.5. Furthermore, specialized nutrients like Vitamin B6 (above 8 mg/kg) can reduce endogenous oxalate production by up to 80%. Omega-3 fatty acids (EPA and DHA) may also lower urinary excretion of oxalate and calcium, and gamma-linolenic acid (GLA) from evening primrose oil has shown potential in reducing urinary calcium in other species.

Urinary care diets also support a healthy microbial environment by providing highly digestible protein over 85% digestibility at approximately 30% crude protein which minimizes undigested protein that could otherwise nourish harmful bacteria.

2.3 CASTRATED MALE CATS AND THEIR PREDISPOSITION TO URINARY TRACT DISEASE

Feline Lower Urinary Tract Disease (FLUTD) is a common and clinically significant syndrome in cats, encompassing a range of disorders affecting the bladder and urethra. Among the various risk factors associated with FLUTD, castration in male cats has been consistently identified as a predisposing factor. This literature review synthesizes current research on the relationship between castration and urinary tract disease in male cats, focusing on prevalence, underlying mechanisms, and associated risk factors. Several epidemiological studies have highlighted the increased prevalence of FLUTD in castrated male cats. Piyarungsri et al. (2020) conducted a study in Chiang Mai, Thailand, and found that 46.2% of FLUTD cases were castrated males, compared to only 1.3% intact females. The study reported a prevalence of 2.24% for FLUTD, with urethral obstruction (55.1%) and hematuria (23.1%) being the most common clinical signs. Similarly, Lekcharoensuk et al. (2001) identified neutered male cats as having a higher risk of FLUTD in the United States, while Sevik et al. (2011) observed the same trend in Norway. These findings suggest that castration significantly elevates the risk of urinary tract disorders in male cats across different geographic regions.

The increased susceptibility of castrated male cats to FLUTD may be attributed to anatomical and physiological changes post-neutering. Borges et al. (2017) demonstrated that castration alters the density of elastic and collagen fibers in the periurethral tissues, reducing urethral compliance and increasing the likelihood of obstruction. Additionally, hormonal changes after castration may influence urinary tract function, though the exact mechanisms remain under investigation. The narrow and curved penile urethra in male cats further exacerbates the risk of obstruction when combined with these structural changes. Multiple studies have identified additional risk factors that compound the predisposition of castrated male cats to FLUTD, which are diet – dry food diets have been linked to FLUTD due to lower water intake and higher urine concentration (Piyarungsri et al., 2020; Lekcharoensuk et al., 2001). Water source – cats drinking tap water were found to have a higher risk compared to those consuming filtered water (Piyarungsri et al., 2020). Litter box management – inadequate litter box availability (fewer boxes than cats in a household) was associated with increased FLUTD risk (Buffington et al., 2006). Obesity and

activity levels neutered male cats are more prone to weight gain and reduced activity, which may contribute to urinary stasis and FLUTD (Jones et al., 1997; Cameron et al., 2004). In conclusion, castrated male cats exhibit a significantly higher predisposition to FLUTD, with contributing factors including anatomical changes post-neutering, dietary influences, and environmental stressors. Future studies should focus on targeted interventions, such as improved hydration strategies and stress reduction, to manage this prevalent condition in neutered male cats. Understanding these risk factors is crucial for veterinarians and cat owners to implement preventive care measures effectively.

2.4 EFFECTS OF NUTRITION CHOICES AND LIFESTYLE CHANGES ON THE WELL-BEING OF INDOOR CATS

The domestic cat (Felis catus), an obligate carnivore, has evolved with unique nutritional and metabolic requirements shaped by its ancestral diet of small prey, which is high in protein, moderate in fat, and low in carbohydrates. Modern indoor lifestyles, however, have introduced significant changes to feline diets and activity levels, often leading to health challenges such as obesity, lower urinary tract disorders, and metabolic imbalances. Therapeutic urinary care diets have emerged as a critical intervention to address urinary tract health, but their broader effects on weight, body condition, and systemic health in healthy cats remain underexplored. Lower urinary tract disorders (LUTD), including feline idiopathic cystitis (FIC) and urolithiasis, are prevalent in domestic cats, particularly in sedentary, indoor populations. Therapeutic urinary care diets are formulated to mitigate these risks by promoting dilute urine through increased water intake, achieved via moderate sodium chloride (4.6% DM) and high protein content, which enhances nitrogen excretion and urine volume. These diets also balance minerals such as magnesium (0.07–0.14% DM) and calcium-phosphorus ratios (0.6–1.0% DM and 0.5–0.9% DM, respectively) to inhibit crystal formation, while pH-modifying ingredients (e.g., DL-methionine, potassium citrate) prevents struvite and calcium oxalate uroliths.

Cats exhibit a fixed, high activity of hepatic enzymes for protein catabolism, necessitating diets rich in high-quality, highly digestible protein (>85% digestibility) to meet nitrogen demands and preserve lean muscle mass. Inadequate protein intake (<2.5–2.7 g/kg BW/day)

risks muscle wasting, immune dysfunction, and metabolic disruptions11. Therapeutic urinary diets often exceed minimum protein requirements (30% crude protein), aligning with cats' evolutionary needs and supporting gastrointestinal health by minimizing undigested protein that could fuel pathogenic bacteria. Indoor cats are prone to obesity due to reduced activity and ad libitum feeding, necessitating careful energy regulation. High-protein diets have proven effective in weight management by preserving lean mass during caloric restriction, with studies recommending >3.3 g protein/kg BW/day to optimize fat loss. Therapeutic urinary diets, while designed for urinary health, may inadvertently support weight management through protein-induced satiety and metabolic efficiency.

2.5 EFFECT OF A STRUVITE DISSOLUTION DIET IN CATS WITH NATURALLY OCCURRING STRUVITE UROLITHIASIS

Feline lower urinary tract disease (FLUTD) is a common condition, with urolithiasis accounting for approximately 10–23% of cases in cats. Among the various urolith types, struvite (magnesium ammonium phosphate) has historically been the most prevalent. Although the proportion of struvite uroliths has declined from nearly 80% three decades ago to about 50% today, struvite remains a significant clinical concern in feline urology. The formation of struvite uroliths is influenced by multiple factors, including urine saturation with mineral components, urinary pH, and dietary composition. Unlike in dogs, struvite formation in cats typically occurs in sterile urine, absent of urease-producing bacteria. This distinction has led to the widespread adoption of dietary management as the primary treatment for feline struvite uroliths Dietary dissolution of struvite uroliths was first demonstrated in 1983, and current guidelines recommend increasing water intake, restricting phosphorus and magnesium, and acidifying urine moderately as primary strategies for both treatment and prevention. More recently, relative supersaturation (RSS) has emerged as a practical metric for assessing the lithogenic potential of urine, with diets designed to maintain struvite RSS below 1 proving effective for both dissolution and prevention Tefft et al. (2020) evaluated a commercially available diet (Blue Natural Veterinary Diet W+U) formulated to reduce struvite RSS and maintain a urine pH around 6.0. In their prospective, open-label, two-center study involving 12 cats with suspected struvite cystoliths, nine cats completed the protocol. Eight of these achieved complete radiographic dissolution, and seven of

them did so within 28 days. One cat required up to 70 days for full resolution. Only one cat failed to dissolve its uroliths fully, and subsequent analysis revealed a calcium oxalate composition, underscoring the importance of accurate stone typing in dietary management.

The findings align with previous studies reporting mean dissolution times ranging from 13 to 30 days for diets with similar acidifying and mineral-restrictive properties. However, (Tefft et al.) also highlighted several challenges, including variability in stone burden, owner compliance, and diagnostic limitations such as reliance on radiography rather than ultrasound. Notably, the diet demonstrated effectiveness even in cats with higher urine specific gravity (USG), suggesting that urine dilution may be less critical in struvite dissolution if an appropriate RSS is achieved. Moreover, the study confirmed that overweight or obese cats a common demographic in the study cohort are particularly prone to struvite urolith formation, likely due to excessive mineral excretion linked to overfeeding. This finding supports the dual role of dietary formulations in both weight and urolith management.

In summary, the literature supports the effectiveness of targeted dietary management for feline struvite urolithiasis. However, the use of therapeutic urinary care feed in healthy cats without struvite urolithiasis has not been explored and there is a gap in knowledge to support the safety of use for owners who would choose to provide therapeutic urinary care feed in hopes of prophylaxis against urolithiasis.

CHAPTER 3

3.0 RESEARCH METHODOLOGY

3.1 ETHICAL CONSIDERATION

Ethics application is required for this study, as the blood, serum and urine sample is obtained from 6 male cats, twice over the course of 11 weeks. The ethics approval code is UMK/FPV/ACUE/RES/003/2025.

3.2 STUDY AREA

This study was conducted in Malaysia among cat owners.

3.3 STUDY DESIGN

This observational study was conducted by providing the therapeutic urinary care feed to clients whose cats were within the targeted animal group—castrated male cats that fulfilled the mentioned criteria—in Malaysia. Pet owners were given the therapeutic urinary care feed to be fed for a 5-week duration. Body weight of cats was expected to increase by 0.5%-1.0% after 5 weeks, body condition score to improve (BCS 4 or 5), urine profile and blood profile to remain within normal parameters, and fecal score to be a score of 2.5. This study was conducted as a prospective, single-group, pre-post interventional study.

Table 1: Nutrition analysis of Therapeutic Urinary Care Feed for cats;

Parameters	Guaranteed analysis
Crude protein % DM (min)	31%
Crude fat % DM (min)	12%
Crude fiber %DM (max)	5%
Moisture % (max)	6.5%

3.4 STUDY POPULATION

The study population includes healthy cats.

3.5 SELECTION CRITERIA

3.5.1 INCLUSION CRITERIA

The inclusion criteria for this study are castrated male cats, whose deworming and vaccination status is up to date, 6 months old and above, body weight of ≤ 6kg, has no history of food allergy, is an indoor cat and has an isolated feeding area if the cat is in a multicat household.

3.5.2 EXCLUSION CRITERIA

The exclusion criteria for this study are cats with urinary tract disease, unhealthy, and have no owner's consent. Cats who have had a history of adverse reaction towards food, cats that are prescribed with prescription diets or special care diets, cats that were scheduled for surgery during the trial period and cats that are in other clinical study within the period of the study which are excluded.

3.6 SAMPLING TECHNIQUE

Cats were recruited based on the predefined inclusion criteria. Each recruited cat underwent a physical examination, and venipuncture was performed to collect baseline blood samples.

Table 2: Recruitment Checklist

	Pass	**Failed**
Physical examination (normal)		
Deworming status		
Vaccination status		
History of food allergy		
CBC (normal)		
Serum biochemistry (normal)		
Urinalysis (normal)		
Body weight within 6kg		
Age at least 6 months old		
Indoor		
Isolated feeding area		

Body weight and body condition score were recorded to document physical status. Feed intake was calculated individually for each cat based on their resting energy requirement (RER) and daily energy requirement (DER) to tailor feeding amounts accurately.

3.7 SAMPLING PROCEDURE

This study evaluated the effects of a therapeutic urinary care feed in healthy castrated male cats by conducting baseline parameters prior to feed trial. Physical examinations, complete blood count (CBC), serum biochemistry for liver and kidney function, and urinalysis. Before the feed trial began, feed intake for all 6 cats was calculated, and fecal score, body weight, and body condition score for all 6 cats were collected before and after treatment trial. The cats involved had an isolated feeding area to ensure controlled conditions for dietary management.

Table 3: Parameters evaluated before and after feed trial

Category	**Parameter**	**Time**
Body condition score	Based on chart	Before Therapeutic Urinary Care Feed Introduction (Day 0) & After Therapeutic Urinary Care Feed Introduction (day 35)
Body Weight	Kg	
Fecal score	Based on chart	
Complete Blood Count	- HGB - HCT - RBC - WBC - PLT	
Serum Biochemistry	- Blood Urea Nitrogen (BUN) - Creatinine	
Urinalysis	- Microscopic evaluation - pH	

3.7.1 Feed plan for feed trial period

Prior to introduction of Therapeutic Urinary Care Feed, owners were advised to transition cats from previous commercial food, over a period of 7 days. The owners were advised to strictly adhere to the table below. During the feed transition, the diet plan was implemented as outlined in the table, ensuring a gradual shift to the Therapeutic Urinary Care diet. After the transition, the Therapeutic Urinary Care diet was fed in amounts calculated based on the cats' individual resting energy requirements (RER), determined using the formula: RER = 70 x BWkg^0.75. Owners were instructed to divide the daily feed amount into two meals and to always provide fresh water.

Table 4: Feed transition method

Day	Percentage of commercial food (%)	Percentage of Therapeutic Urinary Care Feed (%)
1	75%	25%
2	75%	25%
3	50%	50%
4	50%	50%
5	25%	75%
6	25%	75%
7	0%	100%

The feeding requirements for each cat were calculated based on maintenance. For neutered cats, the DER was 1.2 times the RER.

The actual metabolizable energy (ME) of the Therapeutic Urinary Care feed was 344kcal per 100g. The amount of the feed to be fed to the cats was calculated by dividing the DER by ME.

During the feed trial, the daily energy requirement (DER) was calculated according to the table below.

3.7.2 Cephalic Vein Venipuncture

The cat was placed in a sternal recumbency or sitting position. The assistant controlled the cat's head and body to prevent sudden movements. The limb was extended by holding the elbow. The fur around the venipuncture site was shaved to visualise the vein. The assistant used their thumb to occlude the vein proximal to the elbow joint. The venipuncture site was disinfected with 70% alcohol. A 23G needle was inserted directly into the vein, and blood was withdrawn. Digital pressure was applied to the injection site to arrest bleeding. The withdrawal site was observed to confirm the absence of active bleeding or hematoma. Complete Blood Count and Serum Biochemistry were then processed with blood collected in a heparin tube.

3.7.3 Urinalysis

Urine was collected by ultrasound-guided cystocentesis. A 23G needle was used and attached to a 3ml syringe, and urine was collected via puncture to the caudal abdomen, guided with an ultrasound probe while the cat was placed on dorsal recumbency. Urine pH was evaluated immediately using dipstick. Urine cytology was also performed to check for uroliths.

3.7.4 Fecal Score

Fecal scores of cats were assessed using the Royal Canin Fecal Scoring System for cats (1-5 scale). This information was collected via Google Form, an online assessment tool completed by owners in each study phase.

Figure 1: Fecal Score scale based on Royal Canin Chart

3.7.5 Body Condition Score

Cats were assessed using the Royal Canin Body Condition Score Chart (1-9 scale) twice during the study period, before and after feed-trial. Data was collected online via Google Form.

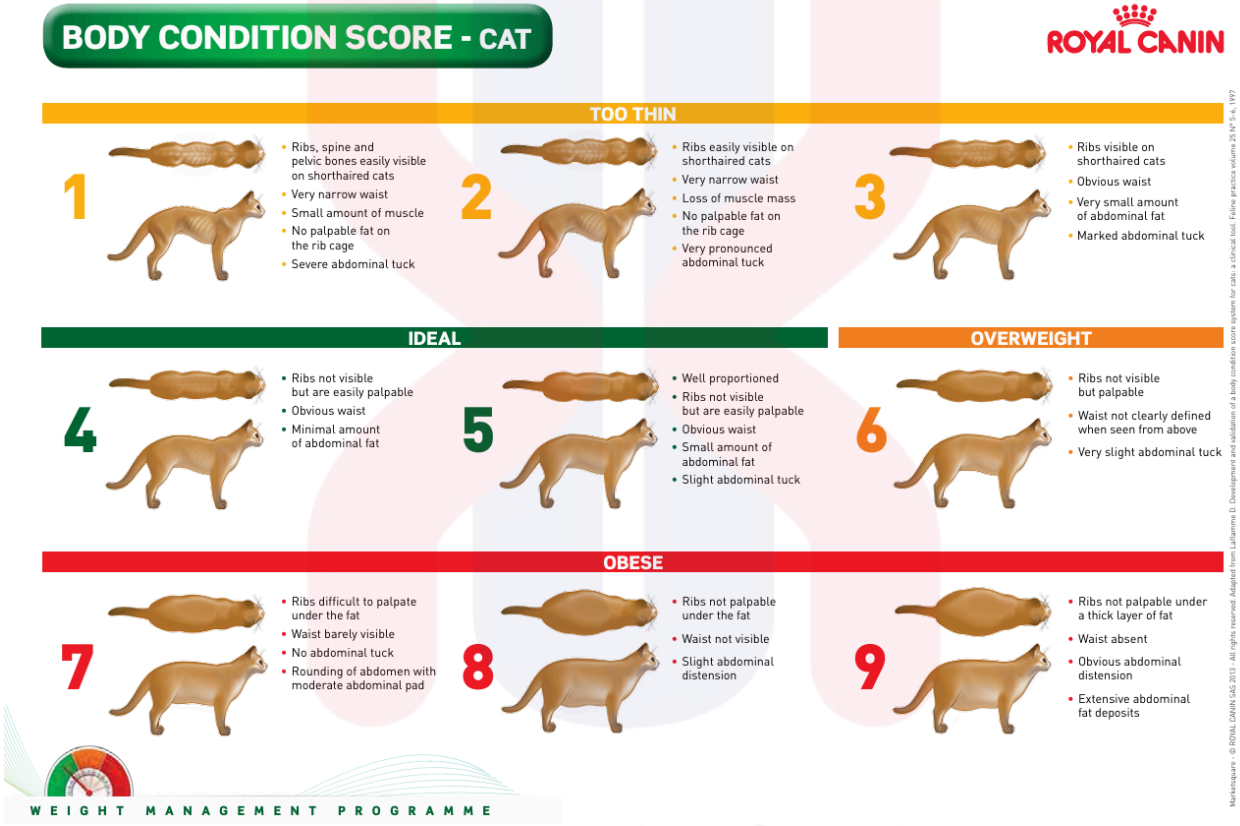


Figure 2: Body condition score based on Royal Canin Chart

3.7.6 Body Weight Assessment

Cats were weighed using a weighing scale in kilograms (kg) twice, before and after the 5 weeks feed trial.

3.8 OWNER COMPLIANCE

Owners were ensured that the therapeutic urinary care feed was only fed to the targeted pet (in multi-pet households), and the targeted pet consumed only the therapeutic urinary care feed throughout the trial phase. Also, owners were instructed to feed the recommended amount of therapeutic urinary care feed to the targeted pet and did not exceed it. Owners were also reminded to not feed any other food to the targeted pet, such as snacks, table scraps, or other pet food. Finally, owners were advised to report any health conditions or abnormalities of the targeted pet during the trial period to the veterinarian. Cats with conditions requiring intervention which may affect the parameters will be disqualified from the study.

3.9 DATA COLLECTION TOOLS

A Google Form was sent to the cat owners to gather data on body weight, body condition score and fecal score at home. The Google form was specifically designed to explore key aspects of the overall health of the cat during the course of the feed trial. The cats were physically assessed twice for sampling of other parameters.
Data from the Google Form and hemogram and urinalysis was collected in Google Sheets.

3.10 DATA ANALYSIS

The data obtained from the cats participating in the feed trial for 5 weeks duration were analyzed and compared with pre-trial body weight, body condition score, fecal score, complete blood count (HGB, HCT, RBC, WBC, PLT), serum biochemistry (BUN, Creatinine), urine cytology and urine pH. The data collected were analyzed using IBM SPSS Statistics. To assess the efficacy of the Therapeutic Urinary Care Feed, paired-samples t-tests were employed to compare pre-trial and post-trial measurements of body weight, body condition score, hematological parameters, serum biochemistry, and urinalysis values. A one-sample t-test was used to evaluate whether the post-trial fecal score maintained the target value of 2.5. Changes in urine cytology outcomes were analyzed using McNemar's test. Statistical significance was set at $p < 0.05$.

CHAPTER 4

4.0 RESULTS

The feed trial included 6 cats that were all castrated males. Breeds represented were Domestic Short Hair (DSH, n=3), Domestic Long Hair (DLH, n=1), Domestic Medium Hair (DMH, n=1) and British Short Hair (BSH, n=1). The cat's age ranged from 2 years old to 6 years old (mean:7 years). The cats received between 68g to 92g feed per day (Table 5).

Table 5: Daily feed requirement for candidates during feed trial

Candidate	Body weight	RER (kcal/day)	DER (kcal/day)	Daily feed requirement (g/day)	Cups (50g)/day
Cat 1	3.95	196.13	235.40	68	1 ¼
Cat 2	5.40	247.97	297.56	86	1 ½
Cat 3	4.70	233.45	280.14	81	1 ⅔
Cat 4	5.90	265.00	317.99	92	2
Cat 5	4.30	209.00	250.83	73	1 ¼
Cat 6	4.00	198.00	237.59	69	1 ¼

The body weight, body condition score, fecal score, blood profile and urine profile was analysed with paired-sample t-test, and the results are interpreted (Table 6).

Table 6: Therapeutic Urinary Care Feed Trial paired samples t-test results

Parameter	T	p-value
Body condition score (BCS) (9 score system)	-	-
Body Weight (kg)	-2.43	0.06
Fecal Score (5 score system)	-	-

Blood Profile		
HGB (g/dl)	-1.35	0.24
HCT (%)	-2.5	0.05
RBC (10^6/µl)	-2.5	0.06
WBC (10^3/µl)	-4.4	0.01
PLT (10^3/µl)	0.8	0.44
BUN (mg/dL)	0.1	0.94
Creatinine (mg/dL)	-0.3	0.78
Urinalysis		
Urine pH	2.2	0.08
Urine cytology	3.1	0.03

4.1.0 BODY WEIGHT

The mean body weight was 4.7 ± 0.7 at baseline and 5.0 ± 0.7 post-intervention. A paired sample t-test confirmed no significant change in body weight (mean difference = -0.3, 95% CI: -0.6 to 0.1, t(5) = -2.4, p = 0.059), supporting the hypothesis that the therapeutic feed has no significant effect on the body weight in healthy cats.

4.1.1 BODY CONDITION SCORE AND FECAL SCORE

For body condition score (BCS) and fecal score, the correlation and t cannot be computed because the standard error of the difference is zero. This indicates that each individual cat's BCS and fecal score remained unchanged throughout the study period. Results obtained for BCS, body weight and fecal score (Table 7).

Table 7: Body Condition Score (BCS), Body Weight and Fecal Score results

Parameter	Average (Before Feed Trial)	Average (After Feed Trial)	p-value
Body condition score (BCS)	5.6	5.6	-
Body weight (kg)	4.7	5.0	0.06
Fecal Score	2.5	2.5	-

4.2 BLOOD PROFILE

Complete blood count parameters (HGB, HCT, RBC, PLT and WBC) and serum biochemistry (BUN and Creatinine) results demonstrated overall stability in most parameters following consumption of the therapeutic feed. Paired samples t-tests indicated that hemoglobin, hematocrit, red blood cell count, platelet count, blood urea nitrogen, and creatinine levels showed no significant changes from baseline ($p > 0.05$). In contrast, white blood cell count decreased significantly during the trial period ($p = 0.007$). It is important to note that despite this statistical significance, all post-intervention values, including WBC, were maintained within normal physiological limits for feline species.

Table 8: Results for blood profile using paired sample t-test

Parameter	Normal Range	Pre-trial (Mean ± SD)	Post-trial (Mean ± SD)	Mean Difference	p-value
HGB (g/dl)	10.0-15.0	12.9 ± 0.6	13.5 ± 1.2	-0.6	0.236
HCT (%)	30.0-45.0	29.4 ± 3.4	32.3 ± 2.7	-2.9	0.054
RBC (10^6/µl)	6.5-10.00	7.4 ± 0.4	7.8 ± 0.2	-0.4	0.055
WBC (10^3/µl)	6.0-15.5	7.9 ± 0.6	9.8 ± 1.3	-1.9	0.007
PLT (10^3/µl)	300-800	345.3 ± 39.4	334.3 ± 26.4	+11.0	0.441
BUN (mg/dL)	16 – 36	19.6 ± 1.0	19.5 ± 3.5	+0.1	0.938
Creatinine (mg/dL)	0.8 – 2.4	2.1 ± 0.1	2.1 ±0.4	-0.1	0.784

The mean urine pH was 6.8 ± 0.7 at baseline and 6.3 ± 0.2 post-intervention. Statistical analysis using a paired sample t-test confirmed no significant change in urine pH (mean difference = +0.5, 95% CI: -0.7 to 1.1, t(5) = +2.2, p = 0.076). Urine pH decreased from a baseline of 6.8 ± 0.7 to 6.3 ± 0.2 after the therapeutic urinary care feed was consumed over a period of 5 weeks. The targeted physiological aim for improving feline urinary health is a more acidic urine environment, which is represented by this 0.5 pH unit shift. Although this directional shift is encouraging, it fell short of the cutoff point for statistical significance (p = 0.076). However, it may indicate that the therapeutic urinary care feed influences urine pH, which may be investigated within a larger sample population.

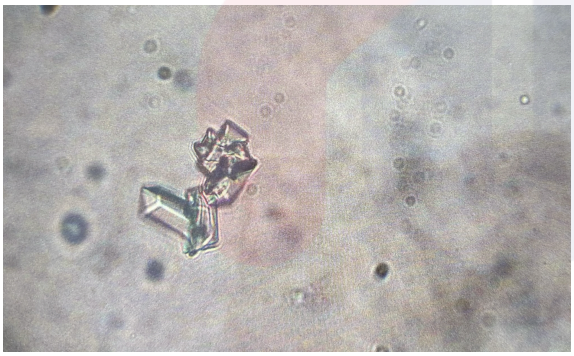
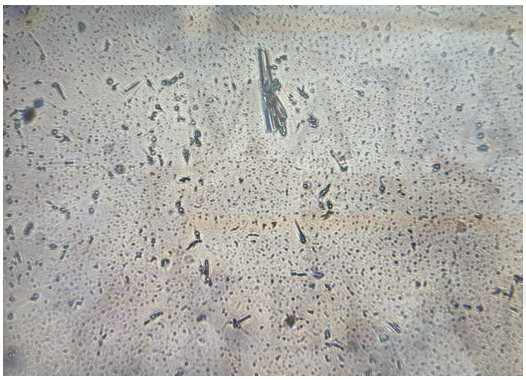
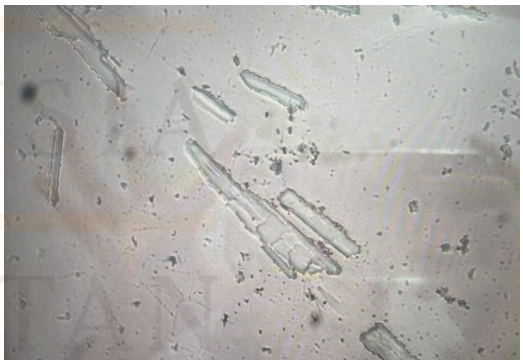
4.3.2 URINE CYTOLOGY

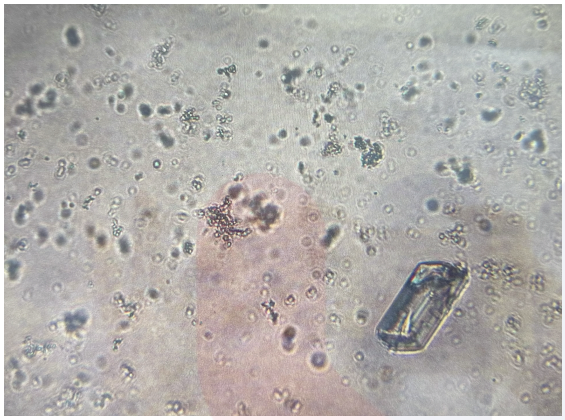
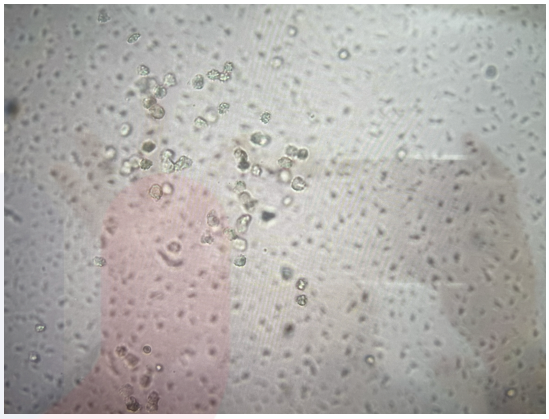
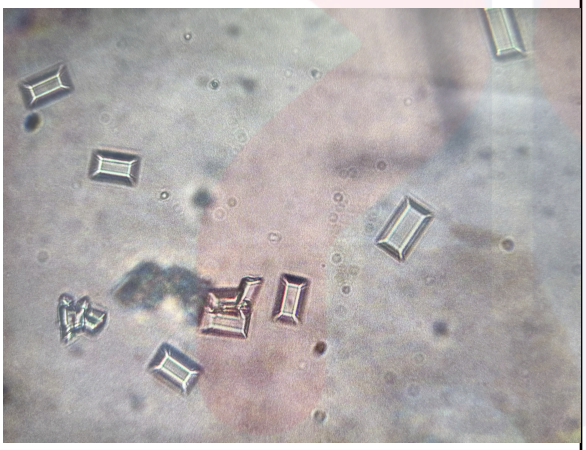
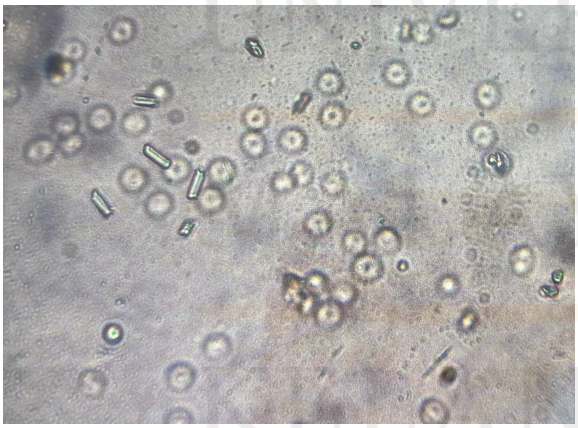
The therapeutic urinary care feed produced substantial results in urine cytology findings. All five out of 6 cats with struvite crystals at baseline converted to negative results post-intervention,

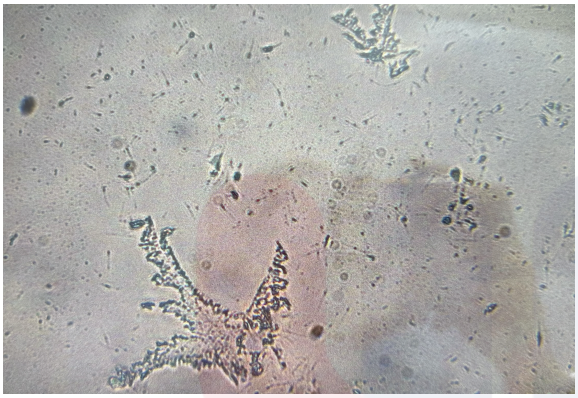
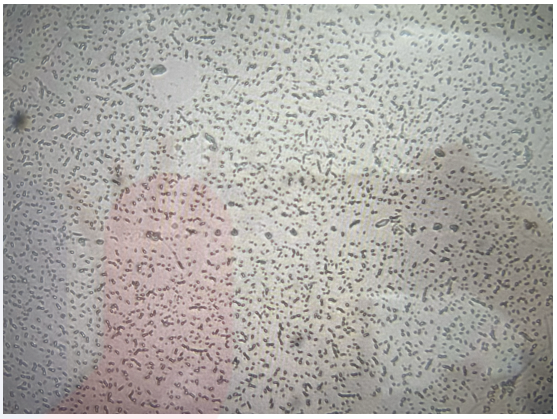
resulting in 100% of the study population showing normal cytology after 5 weeks. This dramatic improvement was statistically significant ($p = 0.031$). The cytological results indicate the therapeutic urinary care feed's efficacy in promoting urinary tract health.

Urine aspirated from the urinary bladder was centrifuged at 2000rpm for 5 minutes, the sediment was smeared onto a glass slide and viewed under the microscope with 10x to 40x magnification. Findings of complete resolution of struvite crystals are documented (Table 8).

Table 9: Microscopic evaluation findings of urine sediment before and after feed trial

	Pre-feed trial (% cats presented with struvite crystals)	**Post-feed trial (0/6 cats presented with struvite crystals)**
Mister	 Struvite crystals	 NSF
Hugo	 Struvite crystals	 NSF

Cream	 Struvite crystals	 NSF
Puff	 Struvite crystals	 NSF
Marbles	 Struvite crystals	 NSF

Duo Duo	 NSF	 NSF

Note: NSF = (No significant findings)

CHAPTER 5

5.0 DISCUSSION

The findings indicated that the therapeutic urinary care feed successfully maintained nutritional status and digestive health, maintained normal and healthy blood profile, and induced clinically significant improvements in urinary parameters, leading up to the resolution of pre-existing struvite crystals.

Maintaining an ideal BCS and stable weight is crucial for overall feline health (German et al., 2015). A primary requirement for any therapeutic urinary care feed is that it supports overall nutritional status without causing unintended weight loss or gain. In this study, the body condition score (BCS) demonstrated stability, with no subjects showing a change from baseline to the end of the feed trial. This absolute consistency, which precluded statistical testing due to a lack of variance, provides strong evidence that the feed effectively maintains body composition (Laflamme, 2012). Similarly, body weight was effectively maintained. At the correct feeding amount, this therapeutic urinary care feed is calorically adequate to prevent weight and muscle loss, a common concern with some therapeutic diets, while not promoting excessive weight gain.

Digestive tolerance is a critical factor for owner compliance and long-term use of any diet. The fecal score results in this study demonstrated the same consistency as the BCS. The maintenance of an ideal score of 2.5 throughout the trial in all cats indicates excellent stool quality and high digestibility. This suggests that the feed's formulation, including its fibre source and level, is well-suited to the feline digestive system, promoting a healthy gut environment and consistent nutrient absorption (Zentek & Freiche, 2018). The absence of any soft stools or diarrhea underscores the feed's suitability for long-term maintenance.

The systemic health safety and maintenance of normal hematological and serum biochemistry profiles in healthy cats on therapeutic urinary care feed is important. This ensures that the feed does not induce pathological change towards the healthy cats consuming this feed. The second hypothesis, which proposed that blood parameters would remain within normal limits, was

supported. The stability of key haematological parameters (HGB, HCT, RBC, PLT) and the significant, though clinically normal, change in WBC indicate no adverse effects on erythropoiesis and leucopoiesis.

Of particular importance to urinary health as the feed given were therapeutic urinary care feed, are the renal parameters, Blood Urea Nitrogen (BUN) and Creatinine. These markers remained stable and within normal reference ranges throughout the study. The maintenance of normal creatinine levels is a strong indicator of stable glomerular filtration rate and renal function (Ross et al., 2006). Furthermore, the stability of BUN suggests that the protein level and quality in the diet are appropriate, supporting metabolic needs without placing undue stress on renal excretion pathways. This profile confirms the feed's safety for systemic health and its appropriateness for cats requiring urinary support without pre-existing renal compromise.

The therapeutic urinary care feed affects the urine pH level by controlling the magnesium levels, and balances calcium and phosphorus levels (Lulich et al., 2016). A healthy cat's normal urine pH value is, ideally between 6.3 to 6.6 (Merck Veterinary Manual, n.d.). Acidic urine is critical for dissolving struvite crystals and preventing their formation (Houston et al., 2004). Despite being not statistically significant, the urine pH of cats in this study was found to be slightly reduced. As this is a desired effect of a therapeutic urinary cat feed, a larger sample size may be helpful to fully confirm its significance.

The most noticeable and strong evidence of the therapeutic urinary care feed's efficacy is the complete resolution of struvite crystals in all five affected cats by the end of the trial, an outcome that was statistically significant ($p = 0.031$). The dissolution of struvite crystals is directly facilitated by a combination of a low urine pH (<6.4) and the use of diets formulated with restricted magnesium and phosphorus (Forrester & Roudebush, 2007). The results of this study demonstrate that the therapeutic urinary care feed successfully created these necessary conditions in vivo. The resolution of crystals is a direct clinical endpoint that translates to a reduced risk of urethral obstruction and feline lower urinary tract disease (FLUTD), representing a significant benefit for feline health (Lekcharoensuk et al., 2001). This finding provides definitive support for

the third hypothesis and solidifies the feed's role as an effective nutritional intervention for promoting urinary tract health.

CHAPTER 6

6.0 CONCLUSION AND RECOMMENDATIONS

The findings of this 5-week feed trial demonstrated that the Therapeutic Urinary Care Feed is a highly effective and safe nutritional intervention for healthy cats. The diet successfully supported overall health by maintaining optimal body condition, body weight, and good digestive tolerance, as evidenced by consistent ideal fecal scores. Also, the feed exhibited a promising systemic safety profile, with no adverse effects on key hematological and serum biochemical parameters, including the important renal parameters such as BUN and creatinine. Most significantly, the feed induced clinically beneficial changes in the urinary environment. The ultimate confirmation of efficacy was the statistically significant resolution of pre-existing struvite crystals in 100% of affected cats. This multifactorial approach of promoting urinary health while supporting overall physiological stability validates the feed's design and fulfills its intended purpose.

For recommendations, in the context of clinical practice, veterinarians can confidently recommend this Therapeutic Urinary Care Feed for the management of healthy cats, especially those with a history of or risk for struvite crystalluria. Its efficacy in resolving crystals, coupled with its high digestibility and ability to maintain ideal body condition, makes it a valuable tool for long-term preventative care. For larger scale studies, a long-term trial spanning 6 to 12 months is recommended to confirm the durability of the results, assess the long-term prevention of urolith recurrence, and further validate the diet's safety over an extended period. The research should also be extended to include a cohort of cats with a confirmed diagnosis of Feline Lower Urinary Tract Disease (FLUTD) to evaluate the diet's efficacy in a clinical patient population alongside healthy subjects.

In summary, this study provides strong evidence that the Therapeutic Urinary Care Feed effectively maintains systemic health and promotes a urinary environment that prevents struvite crystalluria, thereby supporting its use as a nutritional strategy for maintaining feline lower urinary tract health.

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8.0 APPENDICES

Therapeutic Urinary care feed used during feed trial.

Urine dipstick used for urinalysis

Sampling with ultrasound machine prepared for cystocentesis