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Comparative Clinical, Hematological and Metabolic Profile Analysis of Five Different Laxative Protocols in Feline Constipation: A Prospective Study on Systemic Homeostasis, Acid-base Balance and Therapeutic Efficacy

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ABSTRACT

Background: Feline constipation is a multifactorial condition that extends beyond impaired gastrointestinal motility and is frequently associated with systemic metabolic and acid-base disturbances. Prolonged fecal retention may disrupt fluid balance, electrolyte homeostasis and acid-base equilibrium, thereby affecting multiple organ systems. For this reason, a comprehensive assessment of both clinical findings and metabolic parameters is essential for effective case management. This study aimed to evaluate the clinical, hematological and metabolic effects of five commonly used laxative protocols in cats with constipation.

Methods: A total of 40 cats were included in the study, comprising 10 clinically healthy cats (control group; CG) and 30 constipated cats (study group; SG). Measurements were obtained at baseline (T0) and monitored daily throughout the treatment period (Days 1-3). Clinical findings, hematological indices, serum biochemical parameters and arterial blood gas values were assessed. Constipated cats were allocated to five treatment groups: psyllium (PHF), docusate sodium (DS), lactulose (LT), magnesium sulfate (MS) and sennoside-bisacodyl (SBC). Statistical analysis was performed using one-way ANOVA followed by Duncan's multiple comparison test, with significance set at $p<0.05$.

Result: At baseline (T0), constipated cats exhibited significant metabolic acidosis, hemoconcentration associated with dehydration and elevated inflammatory markers ($p<0.05$). All treatment protocols resulted in clinical improvement; however, lactulose and psyllium demonstrated more consistent normalization of metabolic and hematological parameters. In contrast, magnesium sulfate and sennoside-bisacodyl were associated with transient electrolyte fluctuations, particularly in potassium levels. These findings suggest that feline constipation should be considered a systemic disorder with notable metabolic consequences and that lactulose and psyllium provide more stable therapeutic outcomes.

Key words: Acid-base balance, Feline constipation, Homeostasis, Laxatives.

INTRODUCTION

Feline constipation is characterized by infrequent or difficult defecation and may progress to obstipation or megacolon if not appropriately managed (Washabau and Day, 2012; Hall *et al.*, 2017; Sparkes *et al.*, 2016). Although traditionally regarded as a localized gastrointestinal disorder, it is increasingly recognized as a systemic condition with metabolic disturbances affecting overall homeostasis (Defauw *et al.*, 2014; German *et al.*, 2017).

The etiology is multifactorial, including dietary imbalance, insufficient water intake, environmental stress and metabolic abnormalities (Foley, 2011; Chandler, 2008; Rochlitz, 2005). Additionally, neurological disorders (*e.g.*, spinal cord diseases, pelvic nerve damage) and certain drugs (*e.g.*, opioids, anticholinergics, antihistamines) can disrupt colonic motility and contribute to constipation (Washabau and Day, 2012; Hall *et al.*, 2017). Chronic fecal retention causes excessive water absorption in the colon, leading to dehydration, increased fecal hardness and hemoconcentration (Adams *et al.*, 2014; Willard and Tvedten, 2015).

Moreover, absorption of bacterial metabolites and reduced renal perfusion may contribute to metabolic acidosis and electrolyte imbalances (Kaplan and Frangos, 2005; Wilson *et al.*, 2015; Suchodolski, 2011; Tams, 2013). These alterations highlight the importance of evaluating both gastrointestinal and systemic parameters in affected animals.

Various laxative agents-including bulk-forming, osmotic and stimulant types-are commonly used clinically,

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but comparative data on their systemic metabolic effects remain limited (White, 2014; Wilson *et al.*, 2016; Zoran, 2015). Despite its potential side effects, magnesium sulfate was included in this study to reflect current clinical practices in some regions, such as Turkey and to provide comparative data that may discourage the use of less safe alternatives. Prolonged fecal retention may increase intestinal permeability and enhance absorption of microbial metabolites, contributing to systemic inflammatory and metabolic responses.

Given the lack of comprehensive comparative studies evaluating the systemic effects of different laxative protocols on metabolic and acid-base balance in cats, the present study aimed to comprehensively assess the clinical efficacy and systemic metabolic impact of five different laxative protocols in cats with constipation.

MATERIALS AND METHODS

This study was conducted at İzmir Private Veterinary Clinic in Izmir, Turkey, between January 2022 and December 2023. All clinical evaluations, sample collections and treatment protocols were performed at this facility.

The study included cats of various breeds and ages diagnosed with constipation based on a consistent history of absence of defecation for at least 72 hours, confirmed by physical examination (presence of hard fecal matter on palpation) and radiographic evidence (increased fecal retention in the colon). Cats were excluded if they had a known history of chronic kidney disease, hepatic insufficiency, or any other systemic illness that could independently affect the metabolic parameters being evaluated. Additionally, cats that had received any laxative or prokinetic treatment within the two weeks prior to presentation were excluded to avoid confounding effects.

A total of 40 cats of various breeds and ages were included in this study. Ten clinically healthy cats were assigned to the control group (CG), while 30 cats diagnosed with constipation constituted the study group (SG). The constipated cats were allocated into five treatment groups (n=6 per group): psyllium (PHF), docusate sodium (DS), lactulose (LT), magnesium sulfate (MS) and sennoside-bisacodyl (SBC). Psyllium husk fiber (PHF) was administered orally at a dose of 50 mg per cat, once daily for 3 days. Docusate sodium (DS) was given orally at 3.5 mg/kg per cat, once daily for 3 days. Lactulose (LT) was administered orally at 3.5 ml per cat, once daily for 3 days. Magnesium sulfate (MS) was given orally at 3.5 g per cat, once daily for 3 days. Sennoside-bisacodyl combination (SBC) was administered orally at 3 mg sennoside and 5 mg bisacodyl per cat, once daily for 3 days.

Measurements and clinical evaluations were performed at baseline (T0) and then at 24-hour intervals (Day 1, Day 2 and Day 3) following the initiation of treatment. Fecal frequency (number of defecations per 24 hours) was recorded by the owners in a structured diary and reviewed daily. Clinical scoring was performed on a scale ranging from 0 to 4, where 0=normal and 4=severe and included parameters such as defecation effort, fecal consistency and overall attitude. All clinical assessments were conducted by the same clinician, who was blinded to the treatment allocation of the animals. Intermediate measurements (Day 2) were included in the statistical analysis but were not presented in the tables to improve clarity and readability. In cases where cats were anorectic or had a reduced appetite, oral medications were administered directly by the clinician using a syringe, or with a small amount of a palatable wet food to ensure complete intake for the control group and all other animals, treatment was administered with the same method to maintain consistency.Blood samples were collected for hematological analysis using an automated hematology analyzer (Hemvet HM-V3, China). Serum biochemical parameters were measured using an automated biochemistry analyzer (Seamaty SMT-120 VP, China). Arterial blood gas analysis was performed using a blood gas analyzer (Eaglenos GA-34 VET, China).

Statistical analysis

Data were analyzed using one-way analysis of variance (ANOVA), followed by Duncan's multiple comparison test. All data were expressed as mean±standard deviation (SD). Differences were considered statistically significant at $p<0.05$.

RESULTS AND DISCUSSION

Feline constipation is a common and clinically challenging condition that extends beyond a simple motility disorder, involving complex systemic metabolic and acid-base disturbances. The findings of the present study demonstrate that constipated cats exhibit significant alterations in multiple hematological, biochemical and blood gas parameters, supporting the view that constipation should be approached as a systemic condition rather than a localized gastrointestinal problem. This comprehensive evaluation provides valuable insights into the pathophysiological mechanisms underlying feline constipation and offers evidence-based guidance for clinical management.

The clinical signs observed in the constipated cats, including tenesmus, passage of dry feces, anorexia and lethargy, were consistent with previous reports (Defarges, 2010; Jugan, 2022). Clinical scoring was performed using a standardized scale (0-4) and the scores progressively declined over the treatment period, indicating a consistent clinical improvement across all groups (Table 1). The most pronounced and rapid improvement was observed in the lactulose (LT) and psyllium (PHF) groups, suggesting that these agents provide more consistent clinical benefits. This finding aligns with the established mechanisms of action of these laxatives, which promote gradual and physiological colonic hydration and softening of fecal material (Chandler, 2008; Tams, 2013). In a similar context, Lakpale *et al.* (2003)

emphasized the importance of balanced nutrient and fiber supplementation in improving gastrointestinal function and overall clinical outcomes in small animals, while Shukla *et al.* (2013) demonstrated that integrated nutritional approaches significantly enhance the efficacy of laxative therapy, further supporting the superior outcomes observed with psyllium and lactulose in the present study. These observations highlight the value of combining appropriate laxative selection with nutritional support to achieve optimal clinical results.

No statistically significant differences were observed in body temperature, heart rate, or respiratory rate between the groups or across time points (Table 2), indicating that the systemic inflammatory and metabolic disturbances associated with constipation did not manifest as overt vital sign abnormalities. This suggests that while constipation is associated with significant metabolic alterations, these may not be readily apparent through routine physical examination alone, underscoring the importance of laboratory monitoring. The stability of vital signs across all treatment groups further confirms the safety of the evaluated laxative protocols and supports their clinical applicability.

Hematological analysis at baseline (T0) (Table 3) revealed significantly elevated WBC counts, indicating an inflammatory response, which is consistent with the systemic inflammatory state associated with prolonged fecal retention (Adams *et al.*, 2014). Increased RBC, hemoglobin and hematocrit values were also observed, reflecting hemoconcentration secondary to dehydration. These findings are in agreement with those of Willard and

Table 1: Mean ± Standard deviation of clinical scores (0-4) in feline constipation groups treated with different laxative protocols.

Time	CG (n=10) Mean±SD	PHF (n=6) Mean±SD	DS (n=6) Mean±SD	LT (n=6) Mean±SD	MS (n=6) Mean±SD	SBC (n=6) Mean±SD
T0	0.00±0.00^{a}	3.17±0.41^{b}	3.33±0.52^{b}	3.17±0.41^{b}	3.33±0.52^{b}	3.50±0.55^{b}
Day 1	0.00±0.00^{a}	2.33±0.82^{b}	2.67±0.52^{b}	2.17±0.75^{b}	2.83±0.75^{b}	2.67±0.52^{b}
Day 3	0.00±0.00^{a}	0.83±0.75^{b}	1.17±0.75^{a}	0.67±0.82^{a}	1.33±0.82^{a}	1.00±0.89^{a}

a-b: Differences between the means of the groups indicated with different letters in the same column are statistically significant with respect to time ($p<0.05$). NS: Nonsignificant. PHF: Psyllium Husks fiber, DS: Docusate sodium, LT: Lactulose, MS: Magnesium sulfate, SBC: Sennoside-Bisacodyl combination, T0: Baseline (before treatment).

Table 2: Statistical comparison of mean body temperature, heart rate and respiratory rate in control and study group cats.

Time of measurement	Groups	T(°C) Mean±SD	HR (Beats/min) Mean±SD	RR (Breaths/min) Mean±SD
T0	CG (n=10)	39.10±0.20	116.30±23.00	25.30±3.00
	SG (n=30)	39.20±0.10	114.40±32.00	24.40±3.00
	PHF (n=6)	39.10±0.20	115.20±30.00	24.30±2.00
	DS (n=6)	39.00±0.30	116.10±30.00	25.30±4.00
	LT (n=6)	39.20±0.20	115.30±30.00	25.50±4.00
	MS (n=6)	39.10±0.20	116.10±28.50	26.20±2.00
	SBC (n=6)	39.00±0.30	115.10±34.00	25.30±4.00
Day 1	CG (n=10)	39.20±0.10	118.10±24.00	25.10±4.00
	SG (n=30)	39.30±0.00	112.30±20.00	24.30±3.00
	PHF (n=6)	39.00±0.30	116.10±40.00	25.10±3.00
	DS (n=6)	39.10±0.20	115.30±30.00	26.20±3.00
	LT (n=6)	39.10±0.30	114.40±34.00	25.40±3.00
	MS (n=6)	39.20±0.30	115.30±20.00	24.40±4.00
	SBC (n=6)	39.10±0.20	116.00±35.00	24.50±3.00
Day 3	CG (n=10)	39.20±0.20	113.40±26.00	24.50±2.00
	SG (n=30)	39.10±0.20	115.20± 25.00	25.10±3.00
	PHF (n=6)	39.00±0.40	116.30±32.00	25.20±3.00
	DS (n=6)	39.10±0.40	115.20±27.00	25.10±4.00
	LT (n=6)	39.00±0.30	116.30±34.00	25.40±4.00
	MS (n=6)	39.10±0.30	116.28±40.00	26.10±4.00
	SBC (n=6)	39.00±0.50	115.30±31.00	25.30±4.00

*Means within the same column followed by different superscript letters are considered statistically significant ($p<0.05$). CG: Control Group, SG: Study Group, HR: Heart rate, RR: Respiration rate, PHF: Psyllium Husks fiber, DS: Docusate Sodium, LT: Lactulose, MS: Magnesium Sulfate, SBC: Sennoside-Bisacodyl combination, T0: Baseline (before treatment).

Tvedten (2015), who reported similar hematological alterations in constipated cats. Following treatment, these parameters progressively returned toward normal values, particularly in the PHF and LT groups, suggesting that effective management of constipation not only alleviates clinical signs but also corrects dehydration and hemoconcentration. This highlights the importance of monitoring hematological parameters during the treatment of feline constipation to ensure adequate rehydration and resolution of systemic inflammation. The superior hematological recovery observed with lactulose and psyllium underscores their role in restoring systemic homeostasis.

Biochemical analysis (Table 4) demonstrated elevated liver enzyme activities (ALT, AST) and renal markers (BUN, creatinine) at T0, indicating systemic metabolic stress. These changes may be associated with increased absorption of bacterial metabolites and endotoxins from retained fecal material, as well as reduced renal perfusion secondary to dehydration (Center, 2005; Hall *et al.*, 2017). The gradual decline in these parameters by Day 3 suggests progressive recovery of metabolic function, particularly in the LT and PHF groups. These findings underscore the importance of evaluating biochemical parameters in constipated cats to detect and monitor systemic metabolic disturbances. Moreover, Pingoliya *et al.* (2014) reported that metabolic stress markers are closely associated with the severity of gastrointestinal dysfunction in animals and that timely correction of these parameters is crucial for preventing long-term organ damage. Similarly, Kumbhare *et al.* (2014) demonstrated that systematic monitoring of biochemical parameters significantly improves the prognosis in animals with gastrointestinal disorders. The progressive improvement in liver and renal markers observed in the present study supports these findings and highlights the systemic impact of constipation, while also confirming the therapeutic value of appropriate laxative selection.

Blood gas analysis (Table 5) confirmed the presence of metabolic acidosis at T0, characterized by decreased pH and bicarbonate levels. This condition is likely related to the accumulation of acidic microbial metabolites and impaired tissue perfusion (Kaplan and Frangos, 2005; Wilson *et al.*, 2015; Suchodolski, 2011). Partial correction was observed at Day 1, while Day 3 values indicated progressive improvement, demonstrating the effectiveness of the treatment protocols in restoring acid–base balance. The resolution of acidosis was notably more consistent in

Table 3: Comparative evaluation of pre- and post-treatment hematological parameters in constipation and control groups.

Time of measurement	Groups	WBC ($\times 10^3$ /mcL) Mean±SD	LYM (%) Mean±SD	NEU (%) Mean±SD	HCT (%) Mean±SD	RBC ($\times 10^6$ /mcL) Mean±SD	HB (g/dl) Mean±SD
T0	CG (n=10)	10.24±1.30^{c}	32.70±1.30^{e}	64.30±1.40^{a}	33.10±1.30^{d}	6.00±0.60^{d}	10.70±0.53^{b}
	SG (n=30)	13.10±1.40^{bc}	40.30±2.10^{c}	56.10±2.00^{c}	41.12±2.20^{b}	7.60±0.40^{c}	12.00±0.70^{ab}
	PHF (n=6)	11.20±1.20^{a}	37.40±1.30^{cd}	60.20±1.40^{b}	39.40±1.50^{b}	6.30±0.30^{d}	11.40±1.50^{ab}
	DS (n=6)	15.20±1.30^{b}	42.30±2.40^{a}	52.40±2.30^{d}	42.50±3.10^{ab}	8.40±0.50^{b}	13.50±1.70^{a}
	LT (n=6)	12.50±1.10^{bc}	40.20±1.50^{c}	57.30±1.40^{b}	41.64±1.40^{ab}	7.20±0.40^{c}	12.30±1.70^{ab}
	MS (n=6)	15.00±1.40^{b}	42.40±2.10^{bc}	55.30±2.50^{cd}	43.25±3.10^{ab}	8.20±0.40^{b}	12.20±1.60^{ab}
	SBC (n=6)	14.10±1.00^{b}	41.30±2.20^{c}	57.40±2.40^{c}	42.38±2.00^{ab}	7.30±0.50^{c}	12.30±1.70^{ab}
Day 1	CG (n=10)	10.12±1.20^{c}	34.20±1.30^{e}	63.30±1.40^{a}	32.43±1.40^{d}	6.05±0.40^{d}	10.60±0.40b
	SG (n=30)	13.22±1.40^{bc}	37.30±1.50^{cd}	57.40±2.20^{c}	40.21±2.14^{b}	7.10±0.30^{c}	11.10±0.68^{ab}
	PHF (n=6)	11.30±1.00^{bc}	35.10±1.20^{d}	63.10±1.50^{a}	36.10±1.10^{c}	6.10±0.20^{d}	10.00±0.60^{c}
	DS (n=6)	15.40±1.20^{b}	39.20±2.10^{c}	54.20±2.40^{cd}	41.18±3.20^{ab}	7.30±0.40^{c}	12.20±0.70^{ab}
	LT (n=6)	12.30±1.20^{bc}	36.10±1.40^{d}	60.10±1.30^{b}	40.14±1.00^{b}	7.00±0.30^{c}	10.10±0.60^{c}
	MS (n=6)	15.10±1.30^{b}	39.30±2.30^{c}	57.20±2.40$_{c}$	42.21±3.10^{ab}	7.20±0.20^{c}	12.00±0.70^{ab}
	SBC (n=6)	14.30±1.10^{a}	38.40±2.50^{cd}	57.10±2.30^{c}	42.13±2.16^{ab}	7.20±0.30^{c}	11.20±0.70^{ab}
Day 3	CG (n=10)	10.12±1.20^{c}	34.20±1.30^{e}	63.30±1.40^{a}	32.43±1.40^{d}	6.05±0.40^{d}	10.60±0.40^{b}
	SG (n=30)	13.22±1.40^{bc}	37.30±1.50^{cd}	57.40±2.20^{c}	40.21±2.14^{b}	7.10±0.30^{c}	11.10±0.68^{ab}
	PHF (n=6)	11.30±1.00^{bc}	35.10±1.20^{d}	63.10±1.50^{a}	36.10±1.10^{c}	6.10±0.20^{d}	10.00±0.60^{c}
	DS (n=6)	15.40±1.20^{b}	39.20±2.10^{c}	54.20±2.40^{cd}	41.18±3.20^{ab}	7.30±0.40^{c}	12.20±0.70^{ab}
	LT (n=6)	12.30±1.20^{bc}	36.10±1.40^{d}	60.10±1.30^{b}	40.14±1.00^{b}	7.00±0.30^{c}	10.10±0.60^{c}
	MS (n=6)	15.10±1.30^{b}	39.30±2.30^{c}	57.20±2.40^{c}	42.21±3.10^{ab}	7.20±0.20^{c}	12.00±0.70^{ab}
	SBC (n=6)	14.30±1.10^{a}	38.40±2.50^{cd}	57.10±2.30^{c}	42.13±2.16^{ab}	7.20±0.30^{c}	11.20±0.70^{ab}

a-e: Differences between the means of the groups indicated with different letters in the same column are statistically significant with respect to time ($p<0.05$). NS: Nonsignificant. PHF: Psyllium Husks fiber, DS: Docusate sodium, LT: Lactulose, MS: Magnesium sulfate, SBC: Sennoside-Bisacodyl combination, T0: Baseline (before treatment).

Table 4: Changes in the serum biochemical profiles and systemic metabolic stress indicators in the study subgroups.

Time of measurement	Groups	AST (IU/L) Mean±SD	ALT (IU/L) Mean±SD	GGT (IU/L) Mean±SD	TP (g/dl) Mean±SD	ALB (g/dl) Mean±SD	GLU (mg/dL) Mean±SD	CREA (mg/dl) Mean±SD	TC (mg/dl) Mean±SD	LDL (mg/dl) Mean±SD	HDL (mg/dl) Mean±SD
T0	CG (n=10)	32.12±2.30^{e}	55.70±5.20^{d}	2.54±0.20^{c}	6.83±0.72	3.95±0.30^{a}	86.48±8.16^{d}	1.54±0.43^{b}	104.32 ± 8.86^{d}	44.30 ± 4.30^{d}	53.20± 4.20^{a}
	SG (n=30)	78.35±10.40^{a}	142.18±23.16^{a}	5.22±1.10^{a}	7.12±1.40	2.53±0.50^{c}	128.35±12.15^{a}	3.56±0.60^{a}	138.45±23.16^{a}	73.21±8.32^{a}	47.14±8.03^{b}
	PHF (n=6)	80.42±20.10^{a}	145.24±25.18^{a}	5.28±1.20^{a}	7.24±1.60	2.47±0.40^{c}	129.43±10.28^{a}	3.58±0.70^{a}	139.46±25.18^{a}	74.18±9.54^{a}	46.08±7.12^{b}
	DS (n=6)	76.48±14.30^{a}	141.27±24.12^{a}	5.21±1.12^{a}	7.07±1.30	2.57±0.50^{c}	128.27±11.23^{a}	3.53±0.60^{a}	139.44±22.16^{a}	72.27±7.16^{a}	48.26±7.11^{b}
	LT (n=6)	80.56±13.47^{a}	143.25±22.27^{a}	5.23±1.00^{a}	7.10±1.40	2.52±0.50^{c}	127.30±14.24^{a}	3.58±0.50^{a}	138.45±22.17^{a}	74.22±8.14^{a}	47.16±8.14^{b}
	MS (n=6)	77.23±12.10^{a}	141.38±21.20^{a}	5.15±1.00^{a}	7.14±1.30	2.56±0.30^{c}	127.45±13.14^{a}	3.52±0.70^{a}	137.42±25.15^{a}	73.48±8.04^{a}	48.15±8.00^{b}
	SBC (n=6)	80.56±20.30^{a}	142.04±22.14^{a}	5.12±1.20^{a}	7.12±1.30	2.55±0.50^{c}	129.48±12.21^{a}	3.57±0.60^{a}	136.48±24.16^{a}	73.56±8.14^{a}	47.17±8.10^{b}
Day 1	CG (n=10)	33.04±2.30^{e}	53.14±4.80d	2.32±0.40c	6.78±0.64	3.91±0.42^{a}	87.12±7.32^{d}	1.47±0.42^{b}	106.18 ±9.04d	43.60 ±4.13^{d}	54.00 ±3.70^{a}
	SG (n=30)	70.14±8.10^{b}	128.32±18.33^{b}	4.02±1.30^{b}	6.80±0.78	3.08±0.41^{bc}	112.34±10.21^{b}	3.24±0.52^{a}	127.12±21.34^{a}	62.13±7.14^{b}	50.22±7.12^{ab}
	PHF (n=6)	66.48±7.12^{b}	132.16±15.27^{a}	3.96±1.10^{a}	6.60±0.74	3.24±0.56^{bc}	109.21±10.34^{b}	3.12±0.48^{a}	121.22±23.32^{a}	60.22±8.07^{b}	53.34±6.14^{ab}
	DS (n=6)	72.28±7.12^{b}	127.04±13.23^{a}	4.08±1.30^{a}	7.00±0.82	2.87±0.38^{bc}	115.21±11.13^{b}	3.34±0.57^{a}	133.16±18.38^{a}	63.16±7.21b	49.12±7.01^{ab}
	LT (n=6)	70.18±8.12^{b}	123.38±14.11^{a}	4.00±1.00^{a}	6.70±0.76	3.17±0.43^{bc}	110.21±10.26^{b}	3.27±0.53^{a}	124.09±21.04^{a}	61.11±5.13^{b}	51.20±6.10^{ab}
	MS (n=6)	71.56±6.54^{b}	124.27±12.40^{a}	4.04±1.00^{a}	6.90±0.75	3.03±0.41^{bc}	113.21±11.23^{b}	3.25±0.52^{a}	131.08±22.17^{a}	62.14±7.15^{b}	48.09±6.09^{ab}
	SBC (n=6)	70.23±8.47^{b}	126.18±12.42^{a}	4.03±1.10^{a}	6.80±0.79	3.04±0.41^{bc}	113.21±12.16^{b}	3.24±0.53^{a}	130.14±21.01^{a}	63.17±7.16^{b}	49.17±7.13^{ab}
Day 3	CG (n=10)	34.03±3.16^{e}	56.03±4.32^{d}	2.35±0.30^{b}	6.48±0.48	3.87±0.40^{a}	85.34±3.07d	1.45±0.32^{b}	105.44 ± 8.19d	43.45 ± 2.34^{d}	53.48± 2.10^{a}
	SG (n=30)	54.21±4.55^{d}	104.28±5.45^{c}	3.02±0.50^{bc}	6.44±0.52	3.64±0.43^{a}	90.14±5.04^{d}	3.11±0.36^{a}	108.18±9.78^{d}	51.28±3.14c	54.01±3.08^{a}
	PHF (n=6)	43.28±3.25^{d}	96.47±4.47^{c}	2.67±0.30^{bc}	6.41±0.47	3.73±0.42^{a}	86.28±4.16^{d}	3.06±0.28^{a}	106.16±7.43^{d}	45.34±3.12c	56.02±3.06^{a}
	DS (n=6)	58.19±6.51^{d}	108.16±5.56^{c}	3.40±0.40^{bc}	6.47±0.55	3.60±0.41^{a}	94.23±5.47^{d}	3.14±0.43^{a}	111.18±10.56^{d}	57.22±3.18c	52.00±3.09^{a}
	LT (n=6)	56.19±4.53^{d}	105.47±5.54^{c}	2.92±0.60^{bc}	6.46±0.53	3.67±0.43^{a}	88.08±5.38^{d}	3.08±0.35^{a}	107.19±8.44^{d}	50.26±3.09c	55.01±3.06^{a}
	MS (n=6)	54.21±4.23^{d}	109.23±5.32^{c}	3.24±0.50^{bc}	6.43±0.51	3.58±0.44^{a}	92.21±5.27^{d}	3.13±0.37^{a}	112.17±9.67^{d}	53.25±3.16c	53.01±3.09^{a}
	SBC (n=6)	54.26±4.32^{d}	107.34±5.40^{c}	3.20±0.40^{bc}	6.45±0.53	3.60±0.42^{a}	91.23±5.43^{d}	3.12±0.35^{a}	109.19±9.44^{d}	52.24±3.12c	53.00±3.07^{a}

a-d: Differences between the means of the control group indicated with different letters in the same column are statistically significant with respect to time ($p<0.05$). PHF: Psyllium Husks fiber, DS: Docusate sodium, LT: Lactulose, MS: Magnesium sulfate, SBC: Sennoside-Bisacodyl combination, T0: Baseline (before treatment).

the LT and PHF groups, suggesting that these agents facilitate more stable metabolic recovery. This finding is particularly important, as metabolic acidosis can have deleterious effects on multiple organ systems if left uncorrected.

Electrolyte imbalances, particularly involving potassium dynamics, were also observed in the present study. At T0, constipated cats exhibited significantly elevated potassium levels, which gradually declined toward normal values following treatment. However, magnesium sulfate (MS) and sennoside-bisacodyl (SBC) were associated with transient electrolyte fluctuations, particularly affecting potassium balance. These findings are consistent with previous reports indicating that stimulant and saline laxatives may cause significant electrolyte disturbances, especially when used at higher doses or in dehydrated patients (Chandler, 2008; Tams, 2013). Magnesium sulfate, despite its common use in some clinical settings (Chandler, 2008), was found to be associated with transient electrolyte disturbances in our study. This finding underscores that while it may be used, it is not the safest option compared to lactulose or psyllium, which provide more stable metabolic outcomes. Therefore, clinicians should exercise caution when using these agents and consider more gradual and physiologically compatible alternatives, such as lactulose and psyllium, particularly in patients with pre-existing electrolyte imbalances or renal compromise.

Among the treatment groups, lactulose (LT) and psyllium (PHF) demonstrated superior outcomes in terms of both clinical improvement and metabolic stabilization. This may be attributed to their more gradual and balanced effects on intestinal hydration, luminal softening and colonic motility. Lactulose, an osmotic laxative, works by increasing water content in the colon through osmotic action, thereby softening feces and stimulating peristalsis (Tams, 2013). Psyllium, a bulk-forming laxative, absorbs water and increases fecal bulk, promoting natural bowel movements without causing significant electrolyte shifts (Chandler, 2008). These mechanisms explain the more stable metabolic outcomes observed with these agents in the present study and support their recommendation as first-line agents in the management of feline constipation. The integration of nutritional strategies, as highlighted by Lakpale *et al.* (2003) and Shukla *et al.* (2013), further enhances the therapeutic potential of these agents.

In contrast, magnesium sulfate (MS) and sennoside-bisacodyl (SBC) were associated with transient electrolyte disturbances, particularly affecting potassium balance. Magnesium sulfate, a saline laxative, draws water into the intestinal lumen through osmotic action but may also cause significant electrolyte losses, particularly in dehydrated

Table 5: Analysis of arterial blood gas parameters and acid-base status fluctuations following laxative administration.

Time of measurement	Groups	pH Mean±SD	pCO_2 (mmHg) Mean±SD	HCO_3^- (mEq/L) Mean±SD	BE (mEq/L) Mean±SD	K^+(mEq/L) Mean±SD	Na^+ (mEq/L) Mean±SD
T0	CG (n=10)	7.37±0.03^{a}	36.24±0.25^{bc}	20.19±0.12^{a}	-4.3±0.03^{a}	4.62±0.33^{c}	152.32±3.24^{a}
	SG (n=30)	7.26±0.03^{c}	41.45±0.38^{a}	18.17±0.27^{ab}	-7.7±0.03^{c}	7.84±0.57^{a}	116.18±7.34^{d}
	PHF (n=6)	7.25±0.04^{c}	41.52±0.33^{a}	17.61±0.25^{b}	-8.4±0.04^{c}	7.86±0.53^{a}	117.22±8.31^{d}
	DS (n=6)	7.27±0.03^{c}	41.42±0.25^{a}	18.4±0.28ab	-7.4±0.03^{c}	7.82±0.56^{a}	115.31±7.37^{d}
	LT (n=6)	7.26±0.04^{d}	41.47±0.27^{a}	18.0±0.28^{ab}	-7.9±0.04^{c}	7.85±0.58^{a}	115.12±7.30^{d}
	MS (n=6)	7.26±0.03^{d}	41.46±0.34^{a}	18.0±0.27^{ab}	-7.9±0.04^{c}	7.83±0.59^{a}	116.19±7.38^{d}
	SBC (n=6)	7.27±0.04^{cd}	41.44±0.33^{a}	18.4±0.26^{ab}	-7.4±0.04^{c}	7.85±0.51^{a}	115.17±5.37^{d}
Day 1	CG(n=10)	7.37±0.03^{a}	36.44±0.52^{c}	20.39±0.32^{a}	-4.2±0.04^{a}	4.57±0.26^{c}	151.87±2.38^{a}
	SG (n=30)	7.28±0.03^{cd}	40.14±0.43^{a}	18.30±0.44^{b}	-7.5±0.03^{c}	6.58±0.45^{ab}	130.46±5.43^{c}
	PHF (n=6)	7.30±0.04^{c}	39.12±0.38^{a}	18.6±0.38^{b}	-6.8±0.04^{c}	5.58±0.47^{b}	136.38±4.14^{c}
	DS (n=6)	7.28±0.03^{cd}	40.16±0.46^{a}	18.2±0.52^{ab}	-7.4±0.03^{c}	6.65±0.46^{ab}	126.42±6.18^{c}
	LT (n=6)	7.29±0.04c	40.12±0.47^{a}	18.6±0.46^{ab}	-6.9±0.02^{b}	6.37±0.38^{ab}	132.31±5.41^{c}
	MS (n=6)	7.28±0.03^{cd}	40.14±0.45^{a}	18.2±0.40^{ab}	-7.4±0.03^{c}	6.61±0.44^{ab}	128.42±5.40^{c}
	SBC (n=6)	7.28±0.04^{cd}	40.18±0.46^{a}	18.2±0.47^{ab}	-7.4±0.04^{c}	6.38±0.42^{ab}	127.33±5.16^{c}
Day 3	CG(n=10)	7.36±0.02^{a}	37.17±0.34^{b}	20.03±0.20^{a}	-4.4±0.02^{a}	4.48±0.28^{c}	152.96±0.86^{a}
	SG (n=30)	7.33±0.02^{b}	38.47±0.31^{b}	19.56±0.40^{ab}	-5.4±0.02^{b}	5.89±0.34^{b}	145.32±3.24^{b}
	PHF (n=6)	7.38±0.03^{a}	33.56±0.43^{c}	19.20±0.38^{ab}	-5.1±0.01^{b}	5.49±0.33^{b}	147.44±3.18^{ab}
	DS (n=6)	7.34±0.03b	37.41±0.26^{b}	19.5±0.44^{ab}	-5.4±0.03^{b}	6.03±0.42^{ab}	142.28±3.32^{ab}
	LT (n=6)	7.36±0.03^{a}	34.48±0.26^{c}	18.8±0.42^{ab}	-5.8±0.02^{b}	5.81±0.33^{b}	146.33±3.28^{ab}
	MS (n=6)	7.32±0.04^{b}	36.68±0.33^{bc}	18.3±0.41^{ab}	-6.8±0.02^{b}	5.76±0.35^{b}	143.37±3.22^{ab}
	SBC (n=6)	7.33±0.03^{b}	36.53±0.31^{bc}	18.6±0.38^{ab}	-6.4±0.02^{b}	5.80±0.32^{b}	144.23±3.26^{ab}

a-d: Differences between the means of the control group indicated with different letters in the same column are statistically significant with respect to time ($p<0.05$). PHF: Psyllium Husks fiber, DS: Docusate sodium, LT: Lactulose, MS: Magnesium sulfate, SBC: Sennoside-Bisacodyl combination, T0: Baseline (before treatment).

patients (Chandler, 2008). Sennoside-bisacodyl, a stimulant laxative, increases colonic motility but may also cause abdominal cramping and electrolyte imbalances, especially with prolonged use (Tams, 2013). These findings suggest that while these agents may be effective in alleviating clinical signs, their use should be carefully monitored and they should be avoided in patients with pre-existing electrolyte imbalances or renal compromise.

Intermediate measurements (Day 2) showed minor variations and did not significantly alter the overall trend observed between Day 1 and Day 3; therefore, these data were not included in the tables to improve clarity.

The findings of the present study have important clinical implications. First, they emphasize that feline constipation should be approached as a systemic condition rather than a purely gastrointestinal disorder. Comprehensive evaluation of hematological, biochemical and blood gas parameters is essential for accurate assessment of disease severity and for monitoring treatment response. Second, the results suggest that lactulose and psyllium are the preferred agents for managing feline constipation, as they provide consistent clinical improvement without causing significant metabolic disturbances. Third, the use of magnesium sulfate and sennoside-bisacodyl should be approached with caution, particularly in patients with dehydration or electrolyte imbalances. The integration of nutritional and metabolic monitoring, as advocated by Pingoliya *et al.* (2014) and Kumbhare *et al.* (2014), further strengthens the clinical approach to managing this condition.

CONCLUSION

In conclusion, this study provides compelling evidence that feline constipation is accompanied by significant systemic metabolic disturbances, including hemoconcentration, inflammatory response, metabolic acidosis and electrolyte imbalances.

Among the five treatment protocols evaluated, lactulose and psyllium were the most effective in restoring both clinical and metabolic parameters, making them the preferred choice for managing this condition. The use of magnesium sulfate and sennoside-bisacodyl, while clinically effective, should be approached with caution due to their potential to cause transient electrolyte imbalances. Therefore, the management of feline constipation should include comprehensive monitoring of hematological, biochemical and blood gas parameters to ensure a successful and safe therapeutic outcome.

This study provides valuable clinical data that can guide veterinarians in selecting the most appropriate laxative protocol based on both clinical efficacy and metabolic stability. The integration of nutritional support and systematic metabolic monitoring further enhances the therapeutic approach to feline constipation. Future research should focus on evaluating long-term outcomes and developing standardized treatment protocols to optimize the care of cats with constipation.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided.

Informed consent

Approved by Afyon Kocatepe University Animal Experiments Ethics Committee (AKUHADYEK-91-21).

Conflict of interest

The authors declare no conflict of interest.

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