Official Journal Issued by Faculty of Veterinary Medicine

**Benha Veterinary Medical Journal**

Journal homepage: https://bvmj.journals.ekb.eg/

Since 1990

*Original Paper*

# Clinical, hematological and biochemical studies on feline enteritis

**Ahmed Helmy Sobieh[1,2], Hossam El-Din El-Attar[1], Yassein M. Abdel-Raof[1], Mohamed Anwar Ramadan[1], Mahmoud A. Y. Helal[1*]**

[1]*Animal Medicine Department, Faculty of Veterinary Medicine, Benha University, Egypt. PO Box: 13736.*

[2]*Department of Veterinary Services in the Armed Forces, Ministry of Defense. Egypt.*

**ARTICLE INFO**

**Keywords**

*Biochemical*
*Cats*
*Clinical*
*Enteritis*

*Received* 25/03/2024
*Accepted* 19/04/2024
*Available On-Line* 01/07/2024

**ABSTRACT**

Feline enteritis has significant clinical issues that have an impact on their health. We conducted this study on 30 cats suffering from various types of enteritis affection, including viral, bacterial, and parasitic. The study aimed to assess the clinical, hematological and biochemical alterations in cats with various forms of enteritis. The most prevalent clinical signs seen in all forms of enteritis were diarrhea, vomiting, dehydration, and anorexia. Hematological changes revealed a significant reduction in hemoglobin content and red blood cell count than control values in viral and bacterial enteritis. WBCs count and granulocytes were significantly increased in bacterial enteritis. In viral enteritis, there was a significant decrease in lymphocytes and granulocytes, while in parasitic enteritis, there was a significant increase in eosinophils. Different types of enteritis showed significant increases in total protein, globulin, ALT, ALP, and AST, as well as BUN and creatinine, and significant decreases in Ca, P, Na, Cl, and K ions. There was a significant increase in antioxidant enzyme levels, including GSH-Px and SOD, and a significant increase in MDA, inflammatory cytokines, including IL2 and IL6, and acute phase proteins, including HP and CRP, in all affections. These results highlight the complexity of feline enteritis and the demand for specialized treatment strategies to meet the wide range of clinical, hematological and biochemical changes..

## 1. INTRODUCTION

In cats, the digestive system is a critical organ that is susceptible to fatal illnesses. Disorders of this system can be caused by infectious or non-infectious agents (Indarjulianto et al., 2022). Numerous infectious agents can affect the gastrointestinal tract. Viruses, bacteria, and parasites have been demonstrated to induce different degrees of gastroenteritis. The most typical symptoms of gastroenteritis are anorexia, diarrhea, and vomiting. When a cat shows symptoms of acute gastroenteritis, the extent of diagnostic testing varies depending on factors such as clinical signs, history, and the need to check fecal samples for bacterial and parasitic illnesses. A comprehensive assessment has to involve a full blood count and biochemical test (Trotman, 2015).

Feline panleukopenia, a deadly viral illness, puts cats at risk for sepsis and organ failure. Hematobiochemical tests are important for identifying early indications of disease complications because they produce a wide range of clinical symptoms. Fever up to 41°C, lethargy, anorexia, vomiting, diarrhea, and severe dehydration is the most typical clinical manifestations of feline panleukopenia (Kruse et al., 2010). Hemogram examination showed that panleukopenic cats had lower numbers of leukocytes, lymphocytes, granulocytes, erythrocytes, and hemoglobin content (Hb) than healthy cats (Gülersoy et al., 2023). The oxidative biomarkers alterations in cats affected by feline panleukopenia virus include significant decrease in glutathione peroxidase (GSH-Px), and a significant increase in malondhyde dehydrogenase (MDA) concentration in cats with feline panleukopenia infection compared with healthy animals (Khoshvaghti and Nojaba, 2022). Significantly higher MDA and lower GSH-Px were observed in cases of the feline panleukopenia virus, which is typically caused by oxidative stress and may be linked to the virus's activity, which the body's antioxidant system responds to well. (Khoshvaghti and Nojaba, 2022). The host's acute phase response to the feline panleukopenia virus was linked to elevated C-reactive protein (CRP) levels in panleukopenic cats as compared to healthy cats. The panleukopenic cats' elevated blood urea nitrogen (BUN)and creatinine levels may be linked to hypoperfusion brought on by malnourishment and dehydration (Gülersoy et al., 2023). Salmonella is an invasive type of bacteria that damages mucosa, resulting in bleeding, exudation, inflammation, and mucus secretion (Sherding and Johnson, 2006). The primary cause of enteritis is salmonella, a facultative anaerobic bacillus that is gram-negative, motile, and non spore-forming. It is a member of the enterobacteriaceae family (Weese, 2011). Of the primary enteropathogenic bacteria, salmonella species is found in the feline intestinal tract (Paris et al.,2014). The majority of bacterial enteropathogens are linked to self-limiting diarrhea (Marks et al., 2011). Salmonellosis should be suspected in hospitalized dogs or cats developing fever and acute enterocolitis (Carter and Quinn, 2000). The hematological changes in cats affected by feline salmonellosis include normochromic microcytic anemia, and decreased hemoglobin (Ramadhani et al., 2021). Abnormal leucogram alterations in cats affected by feline salmonellosis include leukocytosis, which is

* Correspondence to: Mahmoud.halal@fvtm.bu.edu.eg

characterized by neutrophilia (Giacometti et al., 2017). Cats affected by feline salmonellosis showed elevated aspartate aminotransferase (AST), alanine aminotransferase (ALT), and low levels of serum calcium (Ca) and serum proteins (Giacometti et al., 2017).

Intestinal helminths are one of the most common pathogenic agents in cats (Papazahariadou et al., 2007; Bridger and Whitney, 2009). The main parasites that affect cats and cause severe gastroenteritis include Dipylidium caninum, Isospora felis, and Toxascaris leonina (Purnama et al., 2019). The diagnosis of Dipylidium caninum is done by the parasitological study of the feces, observing the characteristics of the gravid proglottids (Cabello et al., 2011). The gastrointestinal parasites can harm a cat's health, resulting in symptoms like anemia, vomiting, diarrhea, dull hair, listlessness, and occasionally even death, particularly in kittens (Traversa., 2012). No hematological alterations in cats affected by feline parasitic enteritis include red blood cells (RBCs) or hemoglobin (Mohamed et al.,2021). Abnormal leucogram alterations in cats affected by parasitic enteritis are eosinophilia frequently encountered in cats with parasitic enteritis (Maria and Lo, 2016). Kidney enzymes alterations in cats affected with feline parasitic enteritis include high levels of serum BUN and creatinine (Atata et al., 2019). The purpose of this study was to evaluate hematological, biochemical, and clinical alterations in various forms of feline enteritis.

## 2. MATERIAL AND METHODS

*2.1. Animals:*

This study was applied to 100 cats of different sexes (56 male and 44 female), ages (4 months–4 years), and breeds, including Shiraz (n = 59) and Baladi (n = 41), admitted to private pet animal clinics located in Cairo governorate and El Fayoum governorate, Egypt, during the period from November 2021 to March 2023. Thirty cats were selected based on virological, bacteriological, and parasitological examinations and classified into viral enteritis (n = 10), bacterial enteritis (n = 10), and parasitic enteritis (n = 10). These cats were of different sexes (16 male and 14 female), ages (4 months–4 years), and breeds, including Shiraz (n = 19) and Baladi (n = 11). Ten healthy cats were used as controls (5 males and 5 females, 5 Shiraz and 5 Baladi Shiraz breeds). Detailed history gathering, including symptom duration, dietary background, vaccination status, and recent animal interactions. The physical examination focused on signs like abdominal discomfort, diarrhoea characteristics (consistency, colour, presence of blood or mucus), dehydration, body condition, and any accompanying symptoms.

*2.2.Ethical approval:*

All examinations were done after the approval of the ethics committee of Benha University, with the approval number BUFVTM05-05-23. All samples were collected after the owner consented.

*2.3.Samples:*

*2.3.1. Faecal samples*

One faecal sample from each cat suffering from enteritis was used for isolation, and identification of the causative agents was submitted for virological, bacteriological, and parasitological microscopic examinations.

*2.3.2.Blood samples*

Two sets of blood samples were collected from the cephalic veins of cats from different groups. The first blood sample was collected on a labelled test tube with an anticoagulant (potassium salt of EDTA) for the determination of haematological parameters. The second blood sample was collected without anticoagulant, clotted at room temperature for 20 min, centrifuged at 3,000 rpm for 10 min, and then clear non-hemolyzed serum samples were separated and stored at -20 c until subsequent biochemical analysis.

*2.4.Haematological examination:*

Total red blood cells (RBCs), haemoglobin concentration, packed cell volume (PCV), total white blood cells (WBCs), differential leukocytic counts, and platelets were determined by a haematological analyzer (Biotec Hema 21) on freshly collected blood samples with anticoagulant.

*2.5.Biochemical analysis:*

The obtained serum samples were used for the spectrophotometric determination of serum concentrations of total proteins (TP) and globulin, utilising test kits from Spectrum Diagnostics, Egypt. The TP, BUN, creatinine, ALT, alkaline phosphatase (ALP), AST, MDA, superoxide dismutase (SOD), and GSH-Px were analysed using specific kits according to manufacturer instructions (Spectrum Diagnostic Kits, Egypt). The concentration of interleukin-2 (IL-2) and interleukin-6 (IL-6) was calculated using the canine IL-6 duoset enzyme-linked immunosorbent assay (ELISA) (catalogue number DY1609; R&D Systems, Inc.). The analysis included plate preparation, and the assay procedure was performed according to the manufacturer's ELISA protocol. Finally, the microtiter plate was read using a microtiter reader (SLT Spectra, Tecan) at 450 nm (correction wavelength 540 nm). The serum CRP concentration was measured by an ELISA kit according to the method described by Idoate et al. (2015). The following commercial kits were used according to the standard protocol of the suppliers to quantify each MDA (Biodiagnostics, Egypt). Ca (BioMed, Egypt, REF: CAL103100); phosphorus (P) and magnesium (Mg) (Bio-Diagnostic, Giza, Egypt); sodium (Na), potassium (K), and chloride (Cl) levels (Spectrum Company, Egypt) were determined on a selective chemistry analyzer (Apple 302, USA).

*2.6.Virological examination (real-time polymerase chain reaction identification):*

The obtained faecal samples were used for viral identification using real-time polymerase chain reaction (RT PCR). The deoxyribonucleic acid (DNA) of the virus was isolated using the GeneJet genomic DNA extraction kit according to the manufacturer's instructions and the guidelines of Green and Sambrook (2012). Feline panleukopenia virus primers used were: FPV-F 5'-aaacaggaattcactatactaatatattta-3', FPV-R5'-aaatttgaccatttggataaact-3', FPV-Pfam-5'-tggtcctttaactgcattaaataatgtacc-3'tamra (Decaro et al., 2008).

Bacteriological examination:

Faecal samples were collected from cases of diarrhoea (5 cats) for bacterial culture. The isolates recovered were subcultured and further identified using biochemical tests (Alton et al., 1996). The assay for the biochemical properties of the bacterial isolates was conducted according to MacFaddin .(2000)

*2.7. Parasitological and microscopical examinations:*

Faecal samples were collected from cases suffering from diarrhoea for parasitic microscopical examinations. The faecal floatation technique was used for diagnosis (Kaufmann., 1996).

*2.8.Statistical analysis:*
The obtained results were expressed as mean ± SE and analysed using one-way ANOVA to define the significant variance between different groups, followed by pairwise comparison using the Tukey post hoc test (SPSS Statistics for Windows, version 28.0; Armonk, NY: IBM Corp.). A statistically significant difference was considered at a p-value < 0.05.

## 3. RESULTS

Virological findings:
The real-time PCR test on virus DNA showed that the virus DNA found in the 10 cats with viral enteritis was feline panleukopenia virus DNA.
Bacteriological findings
The bacterial isolation test showed that the pathogen found in the bacterial enteritis group of 10 cats was a salmonella species. These were grown on salmonella and shigella agar media and showed up as colorless colonies with a black center. They were identified biochemically on the VITEK system device.
Parasitological and microscopic findings
The microscopic examination results revealed that the most common parasitic eggs detected in the parasitic enteritis group (10 cats) were Dipylidium caninum capsule, Toxascaris leonina egg, and the unsporulated oocyst of Isospora felis (Fig. 1).

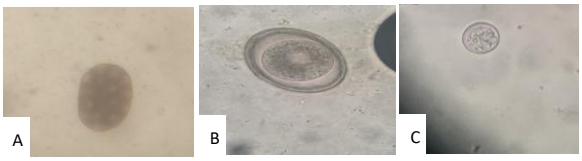


Fig (1) : Fecal microscopical examination showed (A) Dipylidium *caninum* egg capsule containing numerous eggs (B) Egg of *Toxascaris leonina* and(C) Unsporulated oocyst of Isospora *felis*.

Cats suffering from viral enteritis were admitted with a history of bloody diarrhoea, severe vomiting (Fig. 2), anorexia, melena, high fever, severe dehydration, lethargy, and severe depression. There was no history of previous vaccinations. Clinical examination revealed that temperature was significantly increased while respiratory rate was significantly increased (P<0.05) (Table 1).

Pale, visible mucous membranes (Fig. 3) and enlarged superficial lymph nodes were observed.

Fig (2): Male Shiraz cat suffered from viral enteritis showing vomiting .

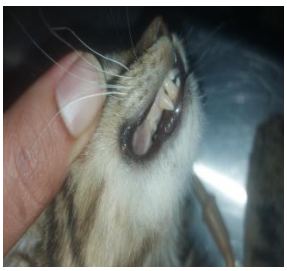

Fig (3) : Female baladi cat suffered from viral enteritis showing pale mucous membrane

Cats suffering from bacterial enteritis were admitted with a history of mild fever, dehydration, mild self-limiting diarrhoea (Fig. 4), and nausea. Physical examination revealed that temperature and respiratory rate were significantly increased (P<0.05) (Table 1). Congested visible mucous membranes and enlarged superficial lymph nodes were observed.
Cats suffering from parasitic enteritis were admitted with a history of macroscopic worms visible in fecal matter in heavy infestation (Fig. 5), constipation, sometimes diarrhea, abdominal discomfort, weight loss, vomiting, and anorexia. The cats had no prior history of deworming and showed no signs of age susceptibility. The physical examination showed no significant changes in temperature, pulse rate, or respiratory rate (Table 1). Pale, visible mucous membranes and normal superficial lymph nodes were observed.

Fig (4): Male shiraz cat suffered from Bacterial enteritis showing yellowish watery diarrhea around anus.

Fig (5) : Female shiraz cat with proglottid of dipylidium caninum around pernium region

Table (1): Physical examination of cats affected with feline viral, bacterial and parasitic enteritis.

| Parameters | Control (N=10) | Viral enteritis (N=10) | Bacterial enteritis (N=10) | Parasitic enteritis (N=10) |
|---|---|---|---|---|
| Temperature (°C) | 38.24±0.11$^{c}$ | 40.56±0.16$^{a}$ | 39.70±0.09$^{b}$ | 37.86±0.20$^{c}$ |
| Pulse rate (Beat/Minute) | 157.40±14.25 $^{a}$ | 135.20±5.01 $^{a}$ | 135.60±8.20 $^{a}$ | 138.00±12.31 $^{a}$ |
| Respiratory rate (Breath/Minute) | 24.60±1.36$^{b}$ | 31.60±1.89$^{a}$ | 31.80±1.46$^{a}$ | 26.00±1.73$^{b}$ |

Data are presented as (Mean ± S.E). S.E = Standard error.
Mean values with different superscript letters in the same row are significantly different at (*P*<0.05).

Haematological findings:
The mean value of RBC count was significantly decreased (P<0.05) in viral enteritis and bacterial enteritis and non-significant change in parasitic enteritis. The mean values of Hb content were significantly decreased (P<0.05) in viral enteritis but not significantly changed in bacterial enteritis or parasitic enteritis. The mean values of PCV% were significantly increased (P<0.05) in viral enteritis, bacterial enteritis, and parasitic enteritis. The mean values of WBC count were significantly decreased (P<0.05) in viral enteritis, significantly increased (P<0.05) in bacterial enteritis, and not significantly changed in parasitic enteritis. The mean values of lymphocytes (%) were significantly decreased (P<0.05) in viral enteritis and not significantly changed in bacterial enteritis and parasitic. The mean values of granulocytes% were significantly decreased (P<0.05) in viral enteritis, significantly increased (P<0.05) in bacterial enteritis, and non-significantly changed in parasitic enteritis. The mean values of eosinophils% and monocytes% were not significantly changed in viral enteritis and bacterial enteritis while significantly increased (P<0.05) in parasitic enteritis (Table 2).

Table (2): Hematological changes in feline viral, bacterial and parasitic enteritis.

| Parameters | Control (N=10) | Viral enteritis (N=10) | Bacterial enteritis(N=10) | Parasitic enteritis(N=10) |
|---|---|---|---|---|
| RBCs (x106/mm3) | 8.92±0.13a | 3.62±0.91c | 6.68±0.84b | 8.71±0.38a |
| Hb (g/dL) | 13.52±0.38a | 8.40±1.61b | 11.12±1.20ab | 13.72±0.67a |
| PCV (%) | 13.56±3.03b | 40.86±1.16a | 34.34±3.67a | 37.80±2.96a |
| WBCs (x103/mm3) | 12.20±1.57b | 0.44±0.28c | 36.14±3.47a | 14.94±5.11b |
| Granulocytes (%) | 50.38±4.70b | 8.74±5.36c | 66.64±3.07a | 56.02±3.27ab |
| Lymphocytes (%) | 33.82±4.39a | 1.98±1.91b | 24.76±3.87a | 32.74±4.49a |
| Eosinophils (%) | 4.20±1.07b | 3.80±0.66b | 4.20±0.37b | 11.20±1.77a |
| Monocytes (%) | 5.20±1.02b | 2.20±0.58b | 4.80±0.20b | 18.20±1.50a |

Data are presented as (Mean ± S.E). S.E = Standard error.
Mean values with different superscript letters in the same row are significantly different at ($P$<0.05).

Biochemical parameters:
The mean values of total protein, globulin, and AST were not significantly changed in viral enteritis, bacterial enteritis, or parasitic enteritis. The mean value of ALT was significantly increased (P<0.05) in viral enteritis and not significantly changed in bacterial enteritis or parasitic enteritis. The mean values of ALP were significantly increased (P<0.05) in viral enteritis, bacterial enteritis, and parasitic enteritis. The mean values of urea and creatinine were significantly increased (P<0.05) in viral enteritis and bacterial enteritis and non-significantly changed in parasitic enteritis. (Table 3).

| Parameters | Control (N=10) | Viral enteritis (N=10) | Bacterial enteritis (N=10) | Parasitic enteritis (N=10) |
|---|---|---|---|---|
| Total Protein (g/dl) | 8.05±0.27$^{a}$ | 7.18±0.46$^{a}$ | 7.53±0.18$^{a}$ | 7.59±0.21$^{a}$ |
| Globulin (g/dl) | 4.24±0.22$^{a}$ | 3.67±0.31$^{a}$ | 4.03±0.12$^{a}$ | 4.25±0.16$^{a}$ |
| AST (u/l) | 22.19±1.75$^{a}$ | 26.49±1.61$^{a}$ | 24.62±2.79$^{a}$ | 24.04±1.63$^{a}$ |
| ALT (u/l) | 28.76±1.77$^{b}$ | 68.43±2.95$^{a}$ | 33.55±1.95$^{b}$ | 28.94±1.24$^{b}$ |
| ALP (u/l) | 26.97±2.58$^{c}$ | 72.26±2.59$^{a}$ | 43.45±2.20$^{b}$ | 38.41±4.34$^{b}$ |
| Urea (mg/dl) | 41.18±3.08$^{b}$ | 72.42±2.17$^{a}$ | 65.12±5.18$^{a}$ | 51.39±6.39$^{a}$ |
| Creatinine (mg/dl) | 0.90±0.04$^{b}$ | 2.06±0.21$^{a}$ | 1.66±0.21$^{a}$ | 0.99±0.23$^{b}$ |

Table (3): Biochemical changes of liver and kidney functions in feline viral, bacterial and parasitic enteritis.
Data are presented as (Mean ± S.E). S.E = Standard error.
Mean values with different superscript letters in the same row are significantly different at ($P$<0.05).

The mean values of Ca, Na, and Cl were significantly decreased (P<0.05) in viral enteritis, bacterial enteritis, and parasitic enteritis. The mean values of K and P were significantly decreased (P<0.05) in viral enteritis and non-significantly changed in bacterial enteritis and parasitic enteritis. (Table 4).

Table (4): Biochemical changes of minerals and electrolytes in feline viral, bacterial and parasitic enteritis.

| Parameters | Control (N=10) | Viral enteritis (N=10) | Bacterial enteritis (N=10) | Parasitic enteritis (N=10) |
|---|---|---|---|---|
| Ca (mg/dl) | 9.14±0.13$^{a}$ | 6.75±0.44$^{b}$ | 7.01±0.25$^{b}$ | 7.60±0.23$^{b}$ |
| P (mg/dl) | 6.32±0.21$^{a}$ | 5.15±0.19$^{b}$ | 6.11±0.14$^{a}$ | 6.08±0.13$^{a}$ |
| Na ( mEq/l ) | 142.54±3.18$^{a}$ | 115.73±4.78$^{b}$ | 119.55±6.34$^{b}$ | 125.72±5.77$^{b}$ |
| K ( mEq/l ) | 6.50±0.35$^{a}$ | 3.90±0.42$^{b}$ | 5.92±0.33$^{a}$ | 5.46±0.20$^{a}$ |
| CL (mEq/l ) | 117.84±3.37$^{a}$ | 91.68±4.49$^{b}$ | 92.33±2.72$^{b}$ | 99.24±3.70$^{b}$ |

Data are presented as (Mean ± S.E). S.E = Standard error.
Mean values with different superscript letters in the same row are significantly different at ($P$<0.05).

The mean values of GSH-Px and SOD were significantly decreased (P<0.05) in viral enteritis, bacterial enteritis, and parasitic enteritis. The mean values of haptoglobin (HP) were significantly increased (P<0.05) in viral enteritis while not significantly changed in bacterial enteritis or parasitic. The mean values of MDA, CRP, and IL6 were significantly increased (P<0.05) in viral enteritis, bacterial enteritis, and parasitic enteritis. The mean values of IL2 were significantly increased (P<0.05) in viral enteritis and bacterial enteritis, while they were not significantly changed in parasitic enteritis (Table 5).

Table (5): Biochemical changes of antioxidants, acute phase proteins and inflammatory cytokines in feline viral, bacterial and parasitic enteritis.

| Parameters | Control (N=10) | Viral enteritis (N=10) | Bacterial enteritis (N=10) | Parasitic enteritis (N=10) |
|---|---|---|---|---|
| GSH-Px (u/mg) | 6.55±0.91$^{a}$ | 3.25±0.16$^{b}$ | 3.33±0.18$^{b}$ | 4.18±0.24$^{b}$ |
| HP (mg/dl) | 39.33±5.78$^{b}$ | 60.85±2.14$^{a}$ | 52.75±4.77$^{ab}$ | 48.38±4.13$^{ab}$ |
| SOD (u/mg) | 16.96±2.27$^{a}$ | 10.30±0.46$^{b}$ | 11.35±0.61$^{b}$ | 11.65±1.90$^{b}$ |
| MDA (nmol/ml) | 11.85±1.26$^{c}$ | 52.22±2.50$^{a}$ | 34.48±8.69$^{b}$ | 29.06±2.04$^{b}$ |
| CRP (U/dL) | 2.02±0.19$^{c}$ | 11.19±0.58$^{a}$ | 10.13±1.19$^{a}$ | 5.66±1.12$^{b}$ |
| IL2 (Pg/ml) | 0.33±0.07$^{b}$ | 1.30±0.16$^{a}$ | 1.01±0.19$^{a}$ | 0.77±0.23$^{ab}$ |
| IL6 (Pg/ml) | 1.93±0.32$^{b}$ | 5.45±0.39$^{a}$ | 4.96±0.33$^{a}$ | 4.47±0.27$^{a}$ |

Data are presented as (Mean ± S.E). S.E = Standard error.
Mean values with different superscript letters in the same row are significantly different at ($P$<0.05).

## 4. DISCUSSION

A range of infectious pathogens can impact the gastrointestinal tract. Different microorganisms, such as bacteria, fungi, viruses, and parasites, have been found to cause different degrees of gastroenteritis (Trotman., 2015).
The cats infected with the virus in this study displayed symptoms of fever, lethargy, anorexia, vomiting, severe dehydration, and diarrhea, which might be attributed to the panleukopenia virus infecting the epithelium of the crypts, destroying any new cells, and ultimately causing the blunting of the villus and denuding of the lamina propria. The severe enteric indications that are typically associated with this condition are caused by the destruction and inflammation of tissue, as well as the resulting decrease in epithelial surface area. These factors significantly impair the small intestine's capacity for absorption and digestion (Tuzio., 2021). These findings were in agreement with

Gülersoy et al. (2023). Clinical findings in cats suffering from infectious (viral) enteritis include severe vomiting, bloody diarrhea, anorexia, melena, high fever, severe dehydration, lethargy, and severe depression. Clinical examination revealed that temperature was significantly increased, pulse rate was not significantly changed, and respiratory rate was significantly increased with pale mucous membranes and enlarged superficial lymph nodes. This result agreed with those of Nahla et al. (2023). In the current investigation, the feline salmonellosis-affected cats showed symptoms of fever, malaise, and anorexia, followed by frequent episodes of vomiting, abdominal pain, and diarrhea. Diarrhea is usually mucoid or watery, but in extreme situations, it can turn bloody. Each cat is different when it comes to the severity of their infection, and these findings agree with Marks et al. (2011). The symptoms of the illness in the present study, which could potentially be attributed to gastroenteritis and septicemia, were agreeable with Stiver et al. (2003). The physical examination of cats affected by feline salmonellosis in the present study showed mild fever, congested mucous membranes, and enlarged superficial lymph nodes, and these findings were agreeable with Giacometti et al. (2017). The cats affected by isospora felis in the present study showed signs of vomiting, mental depression, and ultimately death, especially if immunocompromised, and watery diarrhea, which may sometimes turn bloody. These findings were in agreement with Mitchell et al. (2007) and Barutzki and Schaper (2013). Watery diarrhea is typically caused by Isospora spp., which enter the colon and invade the intestinal mucosa, destroying the intestines and causing malabsorption that results in watery diarrhea (Capári et al., 2013).

The feline panleukopenia virus causes hematological changes in cats, such as decreased red blood cells and hemoglobin levels, and these findings were agreeable with Gülersoy et al. (2023). Anemia has been observed to develop in 50% of cases with the feline panleukopenia virus. and is usually attributed to the long lifespan of erythrocytes unless there is severe gastrointestinal blood loss (Barrs, 2019). There are other possible reasons for lower RBC and Hb counts, such as changes in the bone marrow caused by cytokines or the direct cytotoxic effects of the feline panleukopenia virus (Hartmann, 2010). The hematological alterations in cats affected by feline salmonellosis include normochromic microcytic anemia and decreased hemoglobin, and these findings were agreeable with Ramadhani et al. (2021). Another hematological alteration is elevated PCV, which might be attributed to hemoconcentration from gastrointestinal fluid loss (Sherding and Johnson 2006). No hematological alterations in cats affected by feline parasitic enteritis include RBCs and hemoglobin, and these findings were agreeable with Mohamed et al. (2021). Cats infected with the feline panleukopenia virus often exhibit abnormal leucogram changes, such as leukopenia, which is typified by neutropenia and lymphopenia, and these findings were agreeable with Barrs (2020). The abnormal leukogram patterns detected in the present study can be attributed to the direct cytopathic effects of the feline panleukopenia virus on the bone marrow (Gülersoy et al., 2023). Abnormal leucogram alterations in cats affected by feline salmonellosis include leukocytosis, which is characterized by neutrophilia, which was agreeable with Giacometti et al. (2017). Abnormal leucogram alterations in cats affected by parasitic enteritis are eosinophilia frequently encountered in cats with parasitic enteritis, and these findings were agreeable with Maria and Lo (2016). The abnormal leukogram patterns detected in the present study, which might be attributed to parasites that invade the tissues, including those that migrate through them, induce greater eosinophilia (Maria and Lo, 2016). The lack of variations in the counts of white blood cells and granulocytes between the groups infected with isospora could perhaps suggest that these endoparasites only induce immunosuppression in chronic cases (Atata et al., 2019).

The cats affected by the feline panleukopenia virus in the present study showed hypoglobulinemia, and these findings were agreeable with Sykes (2014). The elevated AST, ALT, and total bilirubin levels of the panleukopenic cats in the present study can be associated with hepatic function loss; feline panleukopenia-related gastroenteritis causing diarrhea, dehydration, malnutrition, and circulatory and metabolic dysfunction can contribute to the elevation of the aforementioned parameters (Hartmann, 2010). The cats affected by feline salmonellosis in the present study showed elevated AST, ALT, and low levels of serum Ca and serum proteins, and these findings were agreeable with Giacometti et al. (2017). Liver enzyme alterations in cats affected by feline parasitic enteritis include high ALP levels and ALT, and these findings were agreeable with Gülersoy and Ekici (2022). High ALP levels might be attributed to the damage and/or necrosis of intestinal tissue (Kumar et al., 2014). Furthermore, it has been noted that in instances of severe infestation, an excessive elevation of these enzyme levels is linked to both insufficient tissue perfusion and increased permeability of intestinal and hepatocyte tissue, which permits more liver enzymes to permeate into the blood stream (Yilmaz and Senturk, 2007).

The panleukopenic cats in this study had elevated BUN and creatinine levels, which may have been related to hypoperfusion brought on by dehydration and anorexia (Gülersoy et al., 2023). Kidney enzyme alterations in cats affected by feline parasitic enteritis include high levels of serum BUN and creatinine, and these findings were agreeable with those of Atata et al. (2019). High kidney enzyme levels might be associated with higher fluid loss and tissue hypoperfusion (Nwoha et al., 2013). Moreover, in situations of cytopathic effect, it could be linked to more severe malabsorption and fluid loss via villous atrophy (Behera et al., 2020). Feline parasitic enteritis was associated with decreased serum albumin levels, which could be explained by the fact that more severe mucosal injury occurs and more protein is lost in secretory diarrhea (Armstrong, 2013). Additionally, the inflammatory process's negative acute phase response could corroborate this finding (Kanno et al., 2019).

Electrolyte alterations in cats affected by the feline panleukopenia virus include significant hypokalemia in cats with feline panleukopenia infection, and these findings were agreeable with Kruse et al. (2010). Electrolyte alterations in cats affected by the feline panleukopenia virus include significant hyponatremia, hypochloremia, and hypocalcemia in cats with feline panleukopenia infection compared with healthy animals, and these findings were agreeable with Sykes (2014). It was reported that a significant decrease in potassium in feline panleukopenia can be explained by anorexia, vomiting, increased gastrointestinal potassium losses, fluid therapy, or a possible refeeding syndrome, which most likely reflects the severity of enteritis (Kruse et al., 2010).

The oxidative biomarker alterations in cats affected by feline panleukopenia virus include a significant decrease in GSH-Px and a significant increase in MDA concentration in cats with feline panleukopenia infection compared with healthy animals, and these findings were agreeable with Khoshvaghti and Nojaba (2022), which might be attributed

to the condition of oxidative stress that appears in feline panleukopenia infection disease, possibly associated with feline panleukopenia virus activity that is well responded to by the body's antioxidant system. The host's acute phase response to the feline panleukopenia virus was linked to elevated CRP levels in panleukopenic cats as compared to healthy cats (Gülersoy et al., 2023), which might be attributed to It is an acute marker for inflammation, and its levels have been shown to increase in viral infections (Hartmann, 2010). The serum CRP levels of the infectious enteritis groups in the present study were high, but the viral enteritis group had the highest CRP level. These results might be attributed to the degree of intestinal inflammatory damage and the existence of a severe inflammatory response (Candellone et al., 2020). IL6 was significantly increased in feline enteritis, which coincided with Kuhn et al. (2014), who reported that IL-6 is increased to promote intestinal epithelial proliferation.

## 5. CONCLUSIONS

These findings demonstrate the complexity of feline enteritis and the need for customized therapeutic approaches to address the various clinical, hematological, and biochemical changes that may occur.

## 6. REFERENCES


1. Alton, G. G., Carter, G. R., Kibor, A. C., and Pesti, L. 1990,'Veterinary diagnostic bacteriology: a manual of laboratory procedures for selected diseases of livestock', FAO Animal Production and Health Paper (FAO) , .(81)Armstrong, P.J. 2013,'GI intervention approach to diagnosis and therapy of the patient with acute diarrhea', Today's Vet Pract. 3, 20-56.
2. Armstrong, P.J. 2013,'GI intervention approach to diagnosis and therapy of the patient with acute diarrhea', Today's Vet Pract. 3, 20-56.
3. Atata, J.A., Esievo, K.A.N., Adamu, S., Abdulsalam, H., Avazi, D.O., and Ajadi, A.A. 2019,' Haematobiochemical studies of dogs with haemorrhageinduced dehydration', Comp Clin Pathol. 28, 129-135. https://doi.org/10.1007/s00580-018-2805-3.
4. Barr, M.C. 2020,'Feline Parvovirus. Clinical Small Animal Internal Medicine', 869-871.
5. Barrs, V. R. 2019,'Feline panleukopenia: a re-emergent disease. Veterinary Clinics: Small Animal Practice', 49(4), 651-670.
6. Barutzki, D., and Schaper, R. 2013,' Age-dependant prevalence of endoparasites in young dogs and cats up to one year of age', Parasitol. Res', 112(Suppl): 119–31. http://dx.doi. org/10.1007/s00436-013-3286-6.
7. Behera, S.K., Singh, Y.D., Roychoudhury, P., Arya, R.S., Behera, P., Ali, M.A., Prasad, H., Sarma, K., Rajesh, J.B., and Chethan, G.E. 2020,'Clinico-pathological and necropsy findings in a 4-month old mixed- breed pup with canine parvovirus-2 infection and its genetic characterization', J EntomolZool Stud. 8,5: 573-577 .
8. Bridger, K. E., and Whitney, H. 2009,'Gastrointestinal parasites in dogs from the Island of St. Pierre off the south coast of Newfoundland', Veterinary parasitology, 162(1-2), 167-170.
9. Cabello, R. R., Ruiz, A. C., Feregrino, R. R., Romero, L. C., Feregrino, R. R., and Zavala, J. T. 2011,'Dipylidium caninum infection. Case Reports', bcr0720114510.
10. Candellone, A., Cerquetella, M., Girolami, F., Badino, P., and Odore, R. 2020', Acute diarrhea in dogs: current management and potential role of dietary polyphenols supplementation. Antioxidants', (Basel) 9,8: 725. https://doi.org/10.3390/antiox9080725 PMid:32784917 PMCid: PMC7465157.
11. Capári, B., Hamel, D., Visser, M., Winter R., Pfister, K., and Rehbein, S. 2013,'Parasitic infections of domestic cats, Felis catus, in western Hungary', Vet. Parasitol. 192: 33–42. http://dx.doi. org/10.1016/j.vetpar.2012.11.011.
12. Carter, M. E., and Quinn, P. J. 2000,'Salmonella infections in dogs and cats. Salmonella in domestic animals', 14, 231-244.
13. Decaro,N., Desario, C., Lucente, M. S., Amorisco, F., Campolo, M., Elia, G., Cavalli, A., Martella, V., and Buonavoglia, C. 2008, 'Specific identification of feline panleukopenia virus and its rapid differentiation from canine parvo virus using minor groove binder probes ', J Virol methods , 147 ,1: 67-71.
14. Giacometti, F., Magarotto, J., Serraino, A., and Piva, S. 2017,'Highly suspected cases of salmonellosis in two cats fed with a commercial raw meat-based diet: health risks to animals and zoonotic implications', BMC Veterinary Research, 13, 1-5.
15. Green, R.M, and J Sambrookn ,J 2012,'Molecular Cloning', A Laboratory Manual (Fourth Edition). Cold Spring Harbor Laboratory Press 4th Edition Publication Date June 15, 2012
16. Gülersoy, E., and Ekici, Y. E. 2022,' Assessment of hematological and serum biochemistry parameters in dogs with acute diarrhea due to different etiologies', Macedonian Veterinary Review, 45(2), 149-156.
17. Gülersoy, E., Erol, B. B., Ok, M., and Sevinç, M. 2023,'Evaluation of qSOFA and variation of hematochemical profile in cats naturally infected with feline panleukopenia virus', Open Veterinary Science, 4(1), 20220118.
18. Hartmann, K. 2010,'Feline panleukopenia–Recognition and management of atypical cases', Anaheim, CA, USA: American College of Veterinary Internal Medicine.
19. Idoate , I., Vander Ley , B., Schultz , L. and Heller , M., 2015 . Acute phase protein in naturally occurring respiratory disease of feedlot cattle . veterinary immunology and immunopathology , 163,3-4, 221-226.
20. Indarjulianto, S., Yanuartono, Y., Nururrozi, A., Raharjo, S., Purnamaningsih, H., Widiyono, I., . and Damayanti, L. P. E. 2022, May ,'Study of Digestive Tract Diseases in Cats', In 7th International Conference on Biological Science (ICBS 2021) (pp. 494-497). Atlantis Press.
21. Kanno, N., Hayakawa, N., Suzuki, S., Harada, Y., Yogo, T., and Hara, Y. 2019,'Changes in canine C-reactive protein levels following orthopaedic surgery', a prospective study. Acta Vet Scand. 61, 33. https://doi.org/10.1186/s13028-019-0468-y PMid:31262326 PMCid:PMC6604448.
22. Kaufmann, J. 1996,'Parasitic infections of domestic animals', a diagnostic manual. ILRI (aka ILCA and ILRAD).
23. Khoshvaghti, A. and Nojaba, E. 2022,'The role of oxidative biomarkers in feline pan- leukopenia', Journal of the Hellenic Veterinary Medical Society, 73(2), 4173–4180. https://doi.org/10.12681/jhvms.26868.
24. Kruse, B. D., Unterer, S., Horlacher, K., Sauter-Louis, C., and Hartmann, K. 2010,'Prognostic factors in cats with feline panleukopenia', Journal of veterinary internal medicine, 24(6), 1271-1276.
25. Kuhn, K.A, Manieri, N.A, Liu T-C, and Stappenbeck, T.S. 2014,'IL-6 Stimulates Intestinal Epithelial Proliferation and Repair after Injury', PLoS ONE 9,12: e114195. https://doi.org/10.1371/journal.pone.0114195.
26. Kumar, M., Sharma, B., Kumar, A., Lal, H.P., Kumar, V., and Tripathi, M.K. 2014,'Prevalence and haemato-biochemical studies of toxocaracanis infestation in dogs and risk perception of zooneses by dog owners in Mathura, India', Asian J Anim Vet Adv. 9,10: 653-663. https://doi.org/10.3923/ajava.2014.653.663.
27. MacFaddin, J, F. 2000,'Biochemical tests for identification of medical bacteria', Williams and Wilkins. Philadelphia, PA, 113.
28. Maria, K. K., and Lo, I. 2016,'The interpretation of leukogram in dog and cat', Hellenic Journal of Companion Animal Medicine• Volume, 5(2), 63.
29. Marks, S. L., Rankin, S. C., Byrne, B. A., and Weese, J. S. 2011,'Enteropathogenic bacteria in dogs and cats: diagnosis, epidemiology, treatment, and control', Journal of veterinary internal medicine, 25,6, 1195–1208. https://doi.org/10.1111/j.1939-1676.2011.00821.x.
30. Mitchell, S.M., Zajac, A.M., Charles, S., Duncan, R.B., and Lindsay. D.S. 2007,'Cystoisospora canisNemeséri, 1959 (syn. Isosporacanis), infections in dogs: clinical signs,

pathogenesis, and reproducible clinical disease in beagle dogs fed oocysts', J. Parasitol. 93: 345–352. http://dx.doi.org/10.1645/GE1024R.1.
31. Mohamed, S. I., Haroun, E. M., Yousif, M., Mursal, W. I., and Abdelsalam, E. B. 2021,'Prevalence and pathology of some internal parasites in stray cats (Felis catus) in Khartoum North Town, Sudan', American Journal of Research Communication, 9, 13-33.
32. Nahla, M., Mouhamed., Asmaa O., Ali., Ibrahim, K.M., Ahmed, E., and Mahmoud. 2023,'Leverage of Gastroenteritis on Blood and Biochemical Profile in Dogs', SCVMJ, XXVIII 1. 45 – 54.
33. Nwoha, R.I.O., Eze, I.O., and Anene, B.M. 2013,'Serum biochemical and liver ezymes changes in dogs with single and conjuct experimental infections of Trypanasoma brucei and Ancylostoma caninum', Afr J Biotechnol. 12,6: 618-624.
34. Papazahariadou, M., Founta, A., Papadopoulos, E., Chliounakis, S., Antoniadou-Sotiriadou, K., and Theodorides, Y. 2007,'Gastrointestinal parasites of shepherd and hunting dogs in the Serres Prefecture, Northern Greece', Veterinary Parasitology, 148,2, 170-173.
35. Paris, J. K., Wills, S., Balzer, H. J., Shaw, D. J., and Gunn-Moore, D. A. 2014,'Enteropathogen co-infection in UK cats with diarrhoea', BMC Veterinary Research, 10, 1-11.702 ,.
36. Purnama, A. W. P., Suwanti, L. T., Plumeriastuti, H., Suprihati, E. and Sunarso, A. 2019,'Prevalence of Gastrointestinal Parasite on Cats in Shelter East Surabaya', Journal of Parasite Science, 3,2, 2019, pp. 47-52.
37. Ramadhani, M. E., Indarjulianto, S., Nururrozi, A., Raharjo, S., and Nakkeeran, A. 2021,'Case Report: Diagnosis and Treatment of Enteritis Caused by Bacterial in a Dog', In BIO Web of Conferences (Vol. 33, p. 06003). EDP Sciences.
38. Sherding, R. G., and Johnson, S. E. 2006,'Diseases of the intestines', Saunders manual of small animal practice.
39. Stiver, S. L., Frazier, K. S., Mauel, M. J., and Styer, E. L. 2003,'Septicemic salmonellosis in two cats fed a raw-meat diet', Journal of the American Animal Hospital Association, 39(6), 538-542.
40. Sykes J. E. 2014,'Feline Panleukopenia Virus Infection and Other Viral Enteritides', Canine and Feline Infectious Diseases, 187–194. https://doi.org/10.1016/B978-1-4377-0795-3.00019-3.
41. Traversa, D. 2012,'Pet round worms and hookworms', a continuing need for global warming. Parasit Vectors.;5:91–110.
42. Trotman, T. K. 2015,'Gastroenteritis. Small Animal Critical Care Medicine', 622–626. https://doi.org/10.1016/B978-1-4557-0306-7.00117-3.
43. Tuzio, H. 2021,'Feline panleukopenia. Infectious disease management in animal shelters', 337-366. , 2nd Edition Lila Miller (Editor), Stephanie Janeczko (Editor), Kate F. Hurley (Editor)ISBN: 978-1-119-29435-1 July 2021 Wiley-Blackwell 656 Pages.
44. Weese, J. S. 2011,'Bacterial enteritis in dogs and cats: diagnosis, therapy, and zoonotic potential', Vet Clin North Am Small Anim Pract. 41(2):287-309.
45. Yilmaz, Z., and Senturk, S. 2007,' Characterization of lipid profiles in dogs with parvoviral enteritis', J Small Anim Prac. 48(11): 643-650. https://doi.org/10.1111/j.1748-5827.2007.00391.x