



International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

© Agronomy

www.agronomyjournals.com

2024; 7(6): 652-658

Received: 06-04-2024

Accepted: 11-05-2024

Dr. Subhash

M.V.Sc Scholar, Department of Veterinary Pathology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

Dr. Deepika Lather

Associate Professor, Department of Veterinary Pathology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

Dr. Vikas Nehra

Senior Scientist & Head, Department of Veterinary Pathology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

Dr. BL Jangir

Assistant Professor, Department of Veterinary Pathology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

Dr. Sushma

Assistant Professor, Department of Veterinary Pathology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

Dr. Paras Saini

Ph.D. Scholar, Department of Veterinary Pathology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

Dr. Gulshan Narang

Dean COVS cum Professor, Department of Veterinary Pathology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

Corresponding Author:

Dr. Paras Saini

Ph.D. Scholar, Department of Veterinary Pathology, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

Investigations on pathomorphological alterations in ruminants affected with gastrointestinal tract disorders

Dr. Subhash, Dr. Deepika Lather, Dr. Vikas Nehra, Dr. BL Jangir, Dr. Sushma, Dr. Paras Saini and Dr. Gulshan Narang

DOI: <https://doi.org/10.33545/2618060X.2024.v7.i6i.946>

Abstract

Gastrointestinal disorders are one of the most important factors that affect the productive and reproductive performance of the animals. Comprehensive studies on such disorders is lacking therefore the present work was planned to aim at patho-biological investigation of gastrointestinal tract disorders affecting large and small ruminants. The current investigation was conducted on 65 cases (bovine, ovine and caprine) brought to the Department of Veterinary Pathology, LUVAS, Hisar from August, 2019 to January, 2020. The investigation included the detailed post-mortem examination of gastrointestinal tract and associated organs, mortality pattern study with relation to digestive disorders, gross pathology and histopathology. Bacteriological and parasitic studies were also carried out to investigate the etiology of gastrointestinal tract disorders. Generalized clinical signs such as weakness, anorexia, diarrhoea, dehydration, tympany and abdominal pain and distention were observed in affected animals. Maximum mortality was observed in more than two-year age group (47.7%) and in calves of upto 6 months age group (38.5%). Main gastrointestinal tract disorders affecting ruminants were acute necro-hemorrhagic type or chronic/granulomatous in nature involved with multiple etiological factors as bacterial infections (*Escherichia coli* and other opportunistic pathogens), paratuberculosis (Johne's disease), coccidiosis and mixed parasitic infections of *Strongyle* spp., *Strongyloides* spp. and *Buxtonella sulcata* complicating the pathology of such disorders.

Keywords: Gastrointestinal tract, pathology, enteritis, hepatitis, lymphadenitis, ruminant

Introduction

Gastrointestinal tract disorders in ruminants are one of the major concerns to veterinarians as well as livestock owners and are usually reported throughout the year that led to high mortality and morbidity among ruminants. The system includes the digestive tract and its associated glands with main function as digestion, absorption and assimilation of nutrients. It is one of the largest and heaviest organ systems of ruminants which normally contain a mixture of commensal and potentially pathogenic organisms. During healthy condition there is continuous interaction between the host and microorganisms resulting in a continuous steady state. The common conditions affecting the gastrointestinal tract are traumatic reticuloperitonitis, diaphragmatic hernia, abscesses, adhesions, impactions, dilatations and motility disturbances which are discernible by clinical signs like anorexia, dullness, recurrent or persistent tympany and abdominal distension (Fidèle *et al.*, 2023; Chanie and Tesfaye, 2012) ^[20, 4].

Most of these conditions are very intricate to distinguish from each other. According to Sharma *et al.* (2015) ^[24], more than 15 percent of all the natural deaths in dairy and beef animals are due to abomasal diseases and resulting peritonitis which are the part of forestomach disorders complex. The gastrointestinal disorders may also occur due to multiple infectious or non-infectious etiological factors including parasites, bacteria, viruses, fungi, foreign bodies (nails, wires, polythene bags etc) and neoplastic conditions (Zachary *et al.*, 2012) ^[31]. There is very limited literature available on comprehensive studies on gastrointestinal tract disorders affecting ruminants. Therefore, the present work was planned to aim at etio-pathomorphological investigation of gastrointestinal tract disorders affecting large and small ruminants.

Materials and Methods

The current investigation was carried out on 65 cases (bovine, ovine and caprine) brought to the Department of Veterinary Pathology, LUVAS, Hisar for post-mortem examination for six months duration i.e. from August, 2019 to January, 2020. The complete history of the cases was recorded including the species, clinical signs and symptoms and treatment if given to the clinically affected animals.

Pathological studies included detailed gross and histopathological examination of gastrointestinal tract organs at the time of post-mortem examination. The ruminant carcasses were divided into different age groups (I-V) to study the age wise mortality pattern. During post-mortem examination forestomach, abomasum, intestine, mesenteric lymph nodes and liver were thoroughly examined and pathological changes were classified according to the lesions observed. For histopathological examination, representative tissue pieces showing lesions were collected in 10% neutral buffered formalin and processed by standard paraffin embedding technique and stained with routine haematoxylin and eosin stain (Luna, 1968) [8]. Bacteriological and parasitic studies were carried out to investigate the etiology of gastrointestinal tract disorders. Bacteriological isolations were attempted from the heart blood, liver and mesenteric lymph nodes of all the animals. Identification and biochemical characterization of each bacterial isolate was done by using Vitek-2 system (Bauer *et al.*, 1966) [1]. Parasitological examination was carried out by standard floatation and sedimentation techniques (Soulsby, 1982) [27].

Results and Discussion

Generalized clinical signs such as weakness, anorexia,

diarrhoea, dehydration, tympany, abdominal pain and distention were observed in most of the carcasses. Age, species and sex wise distribution of mortality in ruminants is presented in table 1. Age-wise distribution of mortality revealed maximum mortality in more than 2 years age group (47.7%) and young ones of up to 6 months age group (38.5%). Sex-wise mortality data revealed that mortality in females (buffalo, cattle and sheep) was higher than their male counterparts. Month-wise mortality distribution revealed maximum in the month of September (29.2%) followed by December, October, November, January and August. McConnel *et al.* (2010) [10] and Londhe (2010) [7] also reported higher mortality in animals above one year of age in bovine.

They suggested that higher mortality in adult animals might be attributed to the stage of their high production and high risk of suffering from traumatic and infectious diseases. A relatively high mortality rate in younger calves might be due to inadequate management or due to improper feeding regime after withdrawal of milk. Higher mortality in female is due to more reports of death as compared to male because farmers are more interested in keeping females (Sushma *et al.*, 2016) [26]. The month wise mortality is presented in table 2 and which revealed that maximum mortality was in the months of September (29.2%) followed by December (23.1%), October (21.5%), November (16.9%), January (6.2%) and August (3.1%). More or less similar results have been reported by Lehreena (2008) [6] and Londhe (2010) [7]. High mortality in above said month might be due to seasonal variations which makes animals particularly the young calves susceptible to many infectious diseases and pathological conditions due to seasonal stress.

Table 1: Percent age-wise, species and sex-wise mortality in ruminants affected with gastrointestinal tract disorders

(n=65)

Groups	Age (mths)	Animals												Grand total with percentage
		Buffalo			Cattle		Total	Sheep		Total	Goat		Total	
		M	F	Total	M	F		M	F		M	F		
I	0-6	11	7	18	2	3	5	0	0	0	2	0	2	25 (38.5%)
II	6-12	0	1	1	0	0	0	1	1	2	0	0	0	3 (4.6%)
III	12-18	0	2	2	1	0	1	0	2	2	0	0	0	5 (7.7%)
IV	18-24	0	0	0	0	0	0	1	0	1	0	0	0	1 (1.5%)
V	≥24	1	16	17	0	4	4	0	7	7	1	2	3	31 (47.7%)
Total		12	26	38	3	7	10	2	10	12	3	2	5	65 (100%)
%age		18.5	40	58.5	4.6	10.8	15.4	3.1	15.4	18.5	4.6	3.1	7.7	100

Table 2: Percent month wise mortality in ruminants affected with gastrointestinal tract disorders

(n=65)

Time period	Mortality of animals					Percentage (%)
	Buffalo	Cattle	Sheep	Goat	Total	
August, 2019	1	1	0	0	2	3.1
September, 2019	13	2	3	1	19	29.2
October, 2019	10	2	1	1	14	21.5
November, 2019	8	2	1	0	11	16.9
December, 2019	6	1	6	2	15	23.1
January, 2020	0	2	1	1	4	6.2
Total cases	38	10	12	5	65	100

The main gross and histopathological lesions observed in gastrointestinal tract organs are presented in Table 3 and 4, respectively. Most prominent gross lesion affecting forestomach was circulatory disturbances (18.5%) followed by perforated reticulum associated with foreign bodies (7.5%; Fig 1), impaction and tympanic rumen (6.2%). Morwal *et al.* (2019) [11] also reported similar conditions in buffaloes at 6-9 year age (most productive age) and concluded that this might be related to the production and sudden dietary changes. Histopathological

examination revealed acute reticulitis (Fig 2) in 20% cases followed by acute omasitis (12.3%; Fig 3), acute rumenitis (7.7%; Fig 4), generalized congestion and hemorrhages (6.2%). Similar to our findings Kumar (2018) [5] also reported rumenitis, reticulitis and omasitis in ruminants. In support to our findings, acute omasitis has also been reported by Puspha (2013) [16] and Sharma (2013) [23]. According to earlier workers rumenitis has been found to be associated with ruminal acidosis (Pacheco and Cruz, 2015; Uzal *et al.*, 2015) [13, 30] which is most often caused

by sudden changes in diet, the consumption of concentrate which are rich in fermentable carbohydrates (Brust *et al.*, 2015) [3]. Present study reported the presence of plastic bags intermixed with feed contents in rumen as major cause of ruminal impaction in bovine carcasses. Berrie *et al.* (2015) [2] suggested fodder scarcity, environmental contamination and poor standards of animal rearing as major factors that cause animals to ingest and accumulate plastic foreign bodies in their rumen. Problem is more often encountered in bovines as they graze close to the ground making them more vulnerable to ingestion of plastic foreign bodies. Caprine are less susceptible to the ingestion of foreign bodies because of their well-developed sensitive prehensile organs and selective feeding behaviour. The penetrating sharp foreign bodies that can accumulate in the reticulum cause focal abscessation, peritonitis, diaphragmatic and pericardial perforation which is called as traumatic reticulopericarditis. Similar to our findings, Ramprabhu *et al.* (2003) [18] also reported incidence of 23.38% in buffalo suffering from traumatic reticuloperitonitis. Similar to our observation Radostits *et al.* (2007) [17] stated that omasum is involved in many gastrointestinal tract disorders but clinical signs and symptoms due to omasal dysfunction are seldom observed and primary diseases of the omasum, such as omasal impaction and omasitis are rare. Major lesions observed in abomasum were vascular changes (congestion, hemorrhages and edematous mucosal folds) in 23 (35.4%) cases followed by mucosal ulcers in 7 (10.8%) cases. Histopathological examination revealed abomasitis in 29 (44.6%) cases followed by vascular changes in 12 (18.5%) cases and ulcerative lesion in 2 (3.1%) cases. Kumar (2018) [5] and Tiwari *et al.* (2018) [29] also reported the similar pathological findings in abomasum. Abomasal ulcers in ruminants have also been elucidated to be associated with stress, concentrated rations and concurrent diseases (Rebhun, 1995) [21]. Gross lesions observed in intestine were vascular changes (46.2%) followed by transverse folds/corrugations (13.8%), catarrhal exudate in lumen (9.2%) and reddish necrotic mucosa (9.2%; Fig.5). Seema *et al.* (2004) [22] also reported the vascular changes in bovine carcasses. Similar corrugations and

thickening of the intestinal mucosa have been also reported by Singh *et al.* (2017) [25] in goats with subclinical paratuberculosis. Histopathological examination of intestine revealed necro-hemorrhagic enteritis (Figs. 6) in 43 (67.7%) cases followed by chronic granulomatous enteritis (Fig. 7) in 9 (13.8%), catarrhal enteritis (Fig. 8) in 7 (10.8%), fibrino-necrotic enteritis in 3 (4.6%) and suppurative enteritis in 2 (3.1%) cases. In corroboration to our findings, Marodia (2017) [9] and Poonia (2018) [15] also reported similar changes in intestines. Similar results regarding granulomatous enteritis were reported by Perez *et al.* (2005) [14] and Sivaseelan *et al.* (2011) [26].

The mesenteric lymph nodes in the present study showed enlargement due to vascular changes (congestion and hemorrhages), necrotic foci and induration with caseation in 18 (27.7%), 13 (20%) and 2 (3.1%) cases, respectively. More or less similar results were also reported by Rano *et al.* (2012) [19] and Tiwari *et al.* (2018) [29]. Histopathological findings revealed acute lymphadenitis (Figs. 9) in 15 (23.1%) cases, chronic lymphadenitis in 14 (21.5%) cases, necrotic lymphadenitis in 6 (9.2%) cases, circulatory disturbances as well as parasitic lymphadenitis in 2 (3.1%) cases each and suppurative lymphadenitis in one (1.5%) case. More or less similar findings in mesenteric lymph nodes were also reported by Sushma *et al.* (2016) [28] and Tiwari *et al.* (2018) [29].

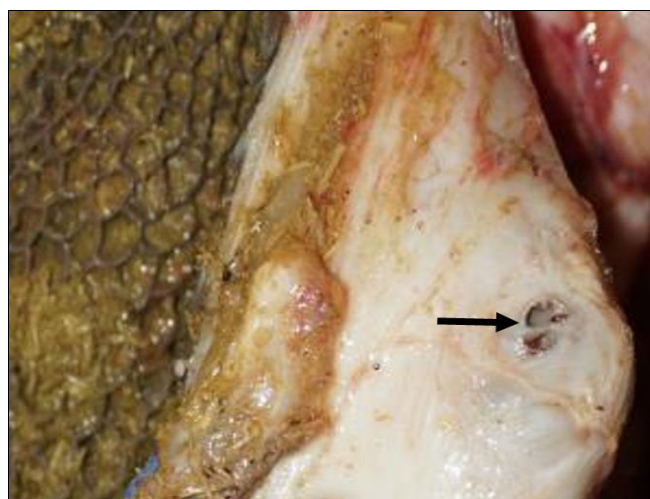
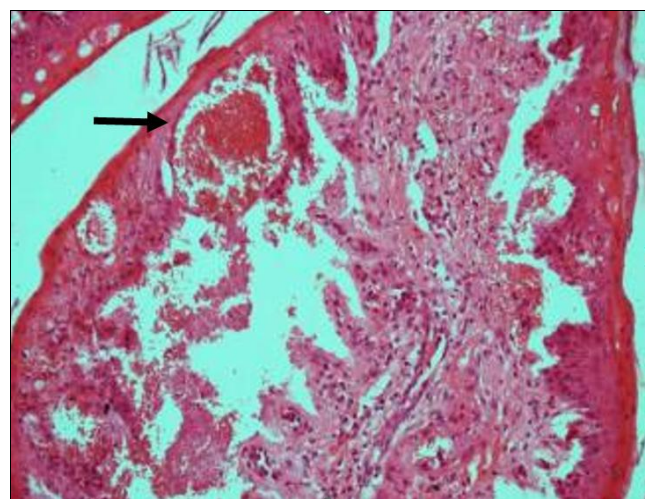
Gross changes observed in liver were pale/white necrotic areas (Fig. 10) in 17 (26.2%) cases followed by hepatomegaly with congestion and mottling in 16 (24.6%) cases, induration in 14 (21.5%) cases and hydatid cysts in 4 (6.2%) cases. More or less similar findings were also reported in bovine by Tiwari *et al.* (2018) [29] and in ovine by Mundotiya (2017) [12]. Sushma *et al.* (2016) [28] also reported induration and hepatomegaly in case of bovine, ovine and caprine. Histopathology of liver revealed degenerative changes in hepatocytes in 25 (38.5%) cases followed by acute focal hepatitis (Fig. 11) in 16 (24.6%) cases, necrotic hepatitis in 14 (21.5%), circulatory disturbances in 6 (9.2%) and cirrhosis (Fig. 12) in 2 (3.1%) cases.

Table 3: Gross pathological lesions observed in gastrointestinal tract of ruminants

	Gross lesions	Buffalo	Cattle	Sheep	Goat	Total	Percentage
Fore-stomach	Vascular changes (Congestion & Hemorrhages)	6	3	2	1	12	18.5
	Ruminal Impaction	3	0	1	0	4	6.2
	Perforated reticulum (Foreign body syndrome/Traumatic reticuloperitonitis)	5	0	0	0	5	7.7
	Tympanic rumen	2	0	0	0	2	3.1
	Total	16	3	3	1	23	
	Percentage (%)	42.1	30	25	20	35.4	
Abomasum	Vascular changes (Congestion & Hemorrhages with edematous mucosal folds)	10	3	8	2	23	35.4
	Abomasal ulcer	6	0	1	0	7	10.8
	Total	16	3	9	2	30	
	Percentage (%)	42.1	30	75	40	46.2	
Intestine	Vascular changes (congestion and hemorrhages)	20	2	7	1	30	46.2
	Catarrhal exudate in lumen	3	2	0	1	6	9.2
	Necrotic mucosa	1	2	1	2	6	9.2
	Transverse folds/corrugations	8	1	0	0	9	13.8
	Total	32	7	8	4	51	
	Percentage (%)	84.2	70	66.7	80	78.5	
Mesenteric Lymph nodes	Enlargement with vascular changes (congestion and hemorrhages)	13	3	1	1	18	27.7
	Enlarged and necrotic foci	7	2	2	2	13	20.0
	Induration and caseation	0	0	2	0	2	3.1
	Total	20	5	5	3	33	
	Percentage (%)	52.6	50	41.7	60	50.8	
Liver	Hepatomegaly associated with congestion and mottling	10	3	2	1	16	24.6
	Pale/white necrotic areas	9	2	4	2	17	26.2
	Induration with distended gall bladder	11	1	2	0	14	21.5
	Hydatid cysts	3	0	1	0	4	6.2
	Total	33	6	9	3	51	
	Percentage (%)	86.8	60.0	75.0	60	78.5	

Table 4: Histopathological lesions observed in gastrointestinal tract of ruminants

Organs	Parameters	Animals				Total	Percentage
		Buffalo	Cattle	Sheep	Goat		
Forestomach	Vascular changes (Congestion & Hemorrhages)	2	1	1	0	4	6.2
	Rumenitis	2	2	1	0	5	7.7
	Reticulitis	9	1	2	1	13	20.0
	Haemorrhagic reticulitis with hyperkeratosis	1	0	0	0	1	1.5
	Omasitis	4	1	2	1	8	12.3
	Haemorrhagic omasitis with hyperkeratosis	0	1	1	0	2	3.1
	Total	18	6	7	2	33	
	%age	47.4	60	58.3	40	50.8	
Abomasum	Vascular changes (Congestion & Hemorrhages)	10	2	0	0	12	18.5
	Abomasitis	14	1	11	3	29	44.6
	Necrotic abomasitis	1	1	0	0	2	3.1
	Total	25	4	11	3	43	
	%age	65.8	40	91.7	60	66.2	
Intestine	Catarrhal enteritis	4	1	2	0	7	10.8
	Necro-haemorrhagic enteritis	28	6	7	3	44	67.7
	Fibrino-necrotic enteritis	2	1	0	0	3	4.6
	Suppurative enteritis	0	0	2	0	2	3.1
	Granulomatous enteritis	4	2	1	2	9	13.8
	Total	38	10	12	5	65	
	% age	100	100	100	100	100	
Mesenteric lymph nodes	Circulatory disturbances (Congestion & Hemorrhages)	2	0	0	0	2	3.1
	Acute lymphadenitis	7	3	3	2	15	23.1
	Chronic lymphadenitis	8	2	3	1	14	21.5
	Necrotic lymphadenitis	3	0	2	1	6	9.2
	Parasitic lymphadenitis	0	1	1	0	2	3.1
	Chronic Granulomatous lymphadenitis	8	2	1	1	12	18.5
	Acute Suppurative lymphadenitis	0	0	1	0	1	1.5
	Total	28	8	11	5	52	
	% age	73.7	80	91.7	100	80	
Liver	Circulatory disturbances (Congestion & Hemorrhages)	3	2	1	0	6	9.2
	Degenerative changes	17	2	4	2	25	38.5
	Focal acute hepatitis	7	4	2	3	16	24.6
	Necrotic hepatitis	10	1	3	0	14	21.5
	Cirrhosis	0	1	1	0	2	3.1
	Total	37	10	11	5	63	
	%age	97.4	100	91.7	100	97	

**Fig 1:** Perforated reticulum with necrosed tract (arrow) due to penetration of pointed objects through reticulum (Adult buffalo)**Fig 2:** Acute hemorrhagic reticulitis characterized by extensive hemorrhages (arrow) in mucosa (Adult buffalo, *Micrococcus luteus*) H&E 400X

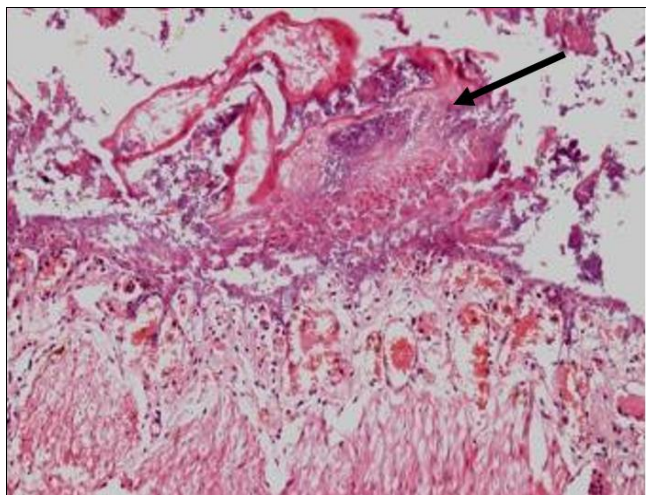


Fig 3: Acute hemorrhagic omasitis characterized by necrosis of mucosal epithelium (arrow), hemorrhages and infiltration of leucocytes (Adult sheep, *Streptococcus spp.*) H&E 200X

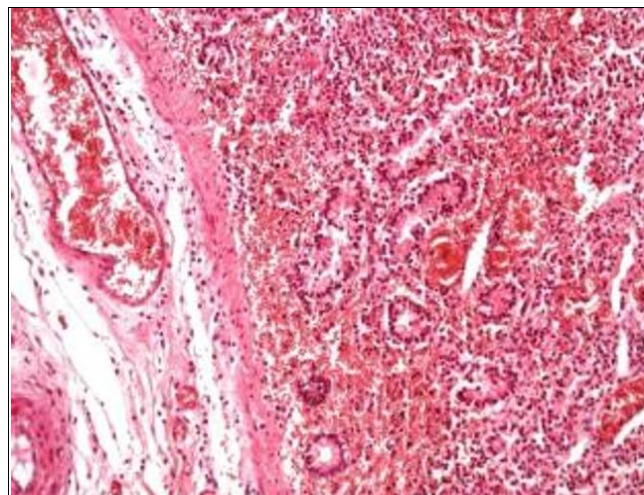


Fig 6: Necrohemorrhagic enteritis with severe hemorrhages in mucosa along with infiltration of leucocytes (Adult buffalo, *Micrococcus luteus* infection) H&E 200X

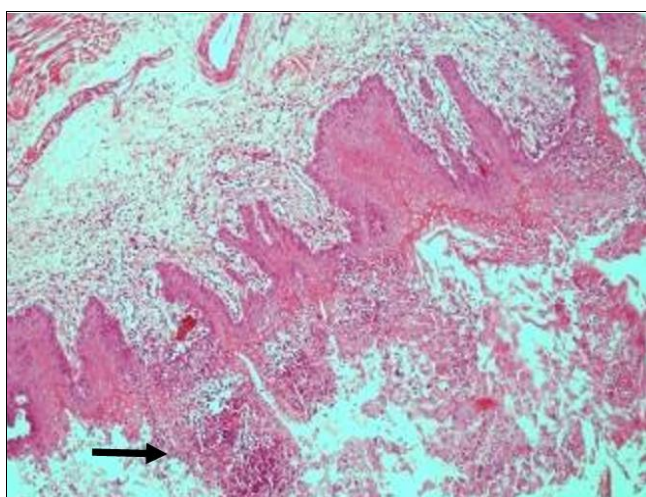


Fig 4: Rumenitis characterized by necrosis of mucosal epithelium (arrow) and infiltration of leucocytes in epithelial mucosa (Cattle-calf) H&E 100X

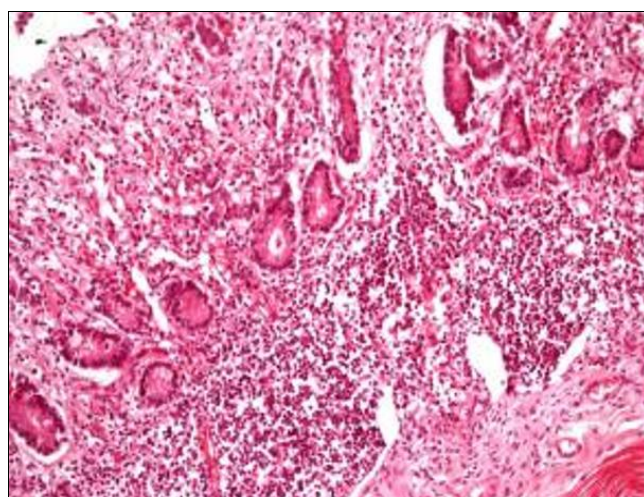


Fig 7: Granulomatous enteritis characterized by thickened mucosa with infiltration of epithelioid cells, macrophages, lymphocytes in submucosa (Cattle calf, MAP positive) H&E 200X



Fig 5: Hemorrhagic intestine with frank blood in the intestinal lumen and congested mucosa (Adult buffalo)

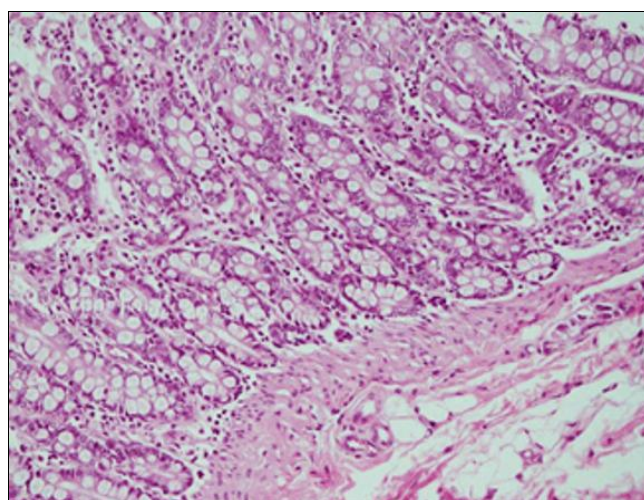


Fig 8: Catarrhal enteritis characterized by hyperplasia of goblet glands and infiltration of leucocytes in mucosa (Adult sheep, *Strongyle spp.* infection) H&E 200X

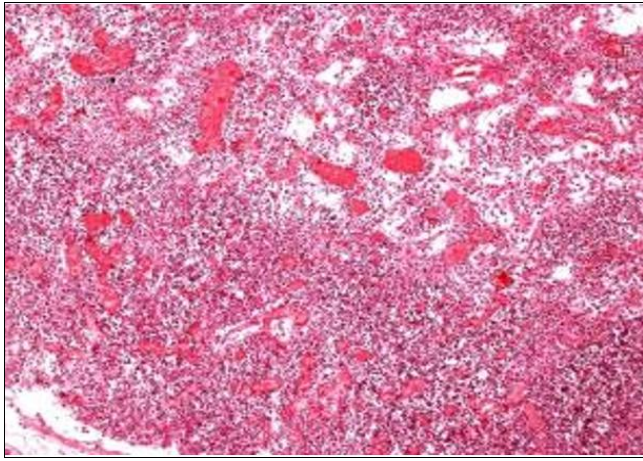


Fig. 9: Acute lymphadenitis characterized by congested blood vessels, necrosis of lymphocytes and infiltration of neutrophils in cortex and medulla (Goat Kid) H&E 100X

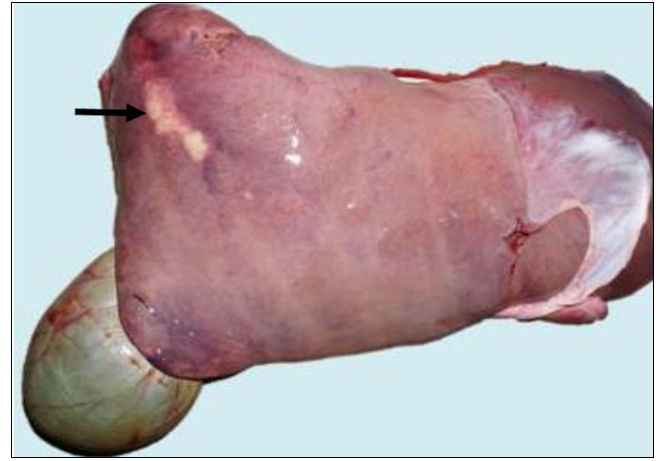


Fig 10: Pale indurated liver with white necrotic areas (arrow) and distended gall bladder (Adult buffalo)

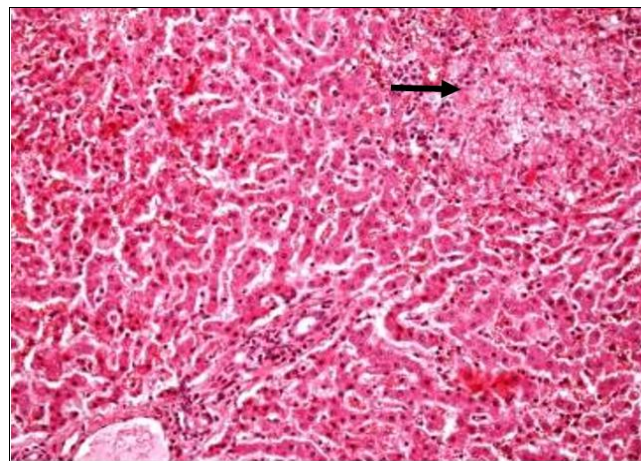


Fig 11: Focal hepatitis characterized by focal coagulative necrosis of hepatocytes (arrow) and infiltration of leucocytes in liver parenchyma (Cattle calf, *Kocuria* spp.) H&E 200X

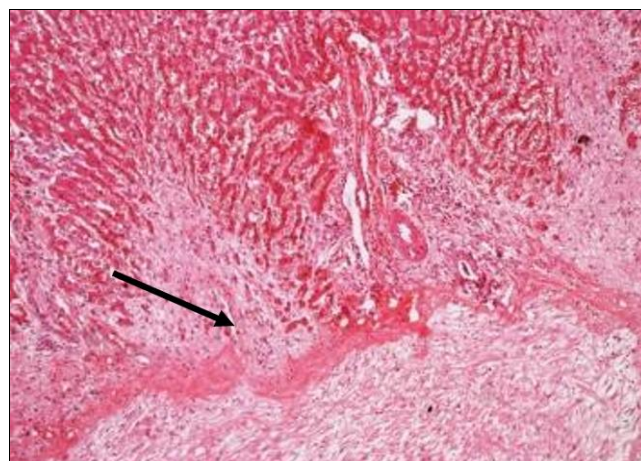


Fig. 12: Cirrhosis characterized by diffuse proliferation of fibrous tissue (arrow) and atrophy of hepatic chords in liver parenchyma. (Adult buffalo, *Micrococcus luteus* infection) H&E 200X

Microbiological studies in present study revealed isolation of different bacterial organisms from 47 cases. *Escherichia coli* (33.8%) was the most prominent bacterial species isolated followed by *Kocuria* spp. (*K. kristinae*, *K. rosea*), *Sphingomonas paucimobilis*, *Pseudomonas mendocina*, *Enterococcus* spp. (*E. faecalis*, *E. faecium*), *Stenotrophomonas multophila*, *Streptococcus* spp. (*S. alactolyticus*, *S. uberis*, *S. gallolyticus* ssp *gallolyticus*), *Staphylococcus* spp. (*S. lentus*, *S. warneri*, *S. hemolyticus*, *S. aureus*), *Proteus mirabilis*,

Salmonella group, *Micrococcus luteus*, *Pseudomonas* spp. (*P. aeruginosa*, *P. oleovarans*). Most of the newly isolated bacteria in the present study belong to opportunistic pathogen group. The parasitological studies revealed parasitic infestations in 30 cases with maximum cases of coccidiosis (*Eimeria* spp.; 15) followed by mixed parasitic infections (10), *Strongyle* spp. (3), *Strongyloides* spp. (1) and *Buxtonella sulcata* (1). Buffalo carcasses revealed parasitic infections in 63.3% cases, ovine in 23.3% cases, cattle in 6.7% cases and caprine in 6.7% cases.

Parasitic conditions were mainly found affecting young bovine calves as compared to adults; while adult sheep and goat were found to be affected more than the young ones.

It is concluded that mortality due to gastrointestinal disorders among large and small ruminants was found to be maximum in adult of more than two years and calves of up to 6 months of age. Main conditions found were acute necro-hemorrhagic or chronic granulomatous type and were found associated with *Escherichia coli* along with other secondary opportunistic pathogens as well as mixed parasitic conditions.

References

- Bauer AW, Kirby WMM, Sherris JC, Turck M. Antibiotic susceptibility testing by a standardized single disk method. *American Journal of Clinical Pathology*. 1966;45(4):493-496.
- Berrie K, Tadesse E, Mossie B. Study on rumen and reticulum foreign body in slaughtered cattle at Gondar Elfora Abattoir. *World Journal of Biology and Medical Science*. 2015;2:133-150.
- Brust LAC, Aragao AP, Bezerra JPS, Galvao A, França TN, Graça FA, Peixoto PV. Cattle diseases associated with consumption of beer residues. *Pesquisa Veterinária Brasileira*. 2015;35(12):956-964.
- Chanie M, Tesfaye D. Clinico-pathological findings of metallic and non-metallic foreign bodies in dairy cattle: A review. *Academic Journal of Animal Diseases*. 2012;1:13-20.
- Kumar A. Occurrence and pathology of various conditions of upper gastrointestinal tract in buffalo (*Bubalus bubalis*). Ph.D. Dissertation, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India; c2018.
- Lehreena. Etio-pathological studies on calf mortality with special reference to hepatic disorders in bovine calves. M.V.Sc. Thesis, Chaudhary Charan Singh Haryana Agricultural University, Hisar, India; c2008.
- Londhe MS. Studies on pathological investigation of gastrointestinal tract of bovines. M.V.Sc. Thesis, Chaudhary Charan Singh Haryana Agricultural University, Hisar, India; c2010.
- Luna LG. *Manual of Histologic Staining Methods of the Armed Forces Institute of Pathology*. 3rd ed. New York: McGraw Hill; c1968.
- Marodia S. Studies on occurrence and pathology of colibacillosis in sheep (*Ovis aries*) in Jaipur Division. M.V.Sc. Thesis, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India; c2017.
- McConnel CS, Garry FB, Hill AE, Lombard JE, Gould DH. Conceptual modeling of postmortem evaluation findings to describe dairy cow deaths. *Journal of Dairy Science*. 2010;93:373-86.
- Morwal S, Sharma SK, Dhuria RK, Goklaney D, Sharma S, Parashar MC, Khinchi RK. Prevalence of fore-stomach disorders in buffaloes in and around Udaipur district in Rajasthan. *International Journal of Chemical Studies*. 2019;7(3):1977-80.
- Mundotiya. Occurrence and pathology of various conditions in liver of sheep (*Ovis aries*) in southern region of Rajasthan. M.V.Sc. Thesis, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India; c2017.
- Pacheco RDL, Cruz GD. Acidosis in cattle. In: *Rumen Microbiology: From Evolution to Revolution*. Springer, New Delhi; c2015. p. 315-27.
- Perez V, Verna A, Munoz M, Garcia-Pariente C, Benavides J, Ferreras M, Marin JG. Immunohistochemical detection of TGF- β in paratuberculosis granulomatous lesions. In: *Proceedings of 8th International Colloquium on Paratuberculosis*. The Royal Veterinary and Agricultural University, Copenhagen; c2005. p. 14-7.
- Poonia R. Occurrence and pathology of various conditions of lower gastrointestinal tract in buffaloes (*Bubalus bubalis*). Ph.D. Dissertation, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India; c2018.
- Puspha. Occurrence and pathology of various conditions of upper gastrointestinal tract in goats (*Capra hircus*). M.V.Sc. Thesis, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India; c2013.
- Radostits OM, Gay CC, Hinchcliff KW, Constable PD. *Veterinary Medicine. A Textbook of the Diseases of Cattle, Sheep, Pigs, Goats and Horses*. 10th ed. Philadelphia: W B Saunders Company Ltd; c2007. p. 3-31, 293-375, 2047-50.
- Ramprabhu R, Dhanapalan P, Prathaban S. Comparative efficacy of diagnostic tests in the diagnosis of traumatic reticuloperitonitis and allied syndromes in cattle. *Israel Journal of Veterinary Medicine*. 2003;58(3):1-7.
- Rano S, Mukhopahayay SK, Ganguly S, Isore DP, Singh YD, Singh KS. Investigation on affected lymph nodes of sheep collected from abattoirs in Kolkata, India. *Exploratory Animal and Medical Research*. 2012;1(2):177-180.
- Fidèle TD, Roland MN-T, Almamy K, Adama K, Hamidou TH, Gaston BAM. Ethnoveterinary study on livestock practices and the use of medicinal plants against gastrointestinal parasites of small ruminants in the BWA community in Burkina Faso. *Int J Vet Sci Anim Husbandry*. 2023;8(4):100-107. DOI:10.22271/veterinary.2023.v8.i4b.575.
- Rebhun WC. Diseases of the abomasum. In: *Textbook of Diseases of Dairy Cattle*. Philadelphia: Lea and Febiger-Co; c1995. p. 124-38.
- Seema. Etiopathomorphological studies of buffalo calves mortality. M.V.Sc. Thesis, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India; c2004.
- Sharma. Occurrence and pathology of various conditions of upper gastrointestinal tract in sheep (*Ovis aries*). M.V.Sc. Thesis, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, India; c2013.
- Sharma AK, Dhaliwal PS, Randhawa CS. Epidemiological studies on forestomach disorders in cattle and buffaloes. *Veterinary World*. 2015;8(9):1063-1067.
- Singh UM, Tripathi BN, Paliwal OP. Progressive pathological changes in subclinical experimental paratuberculosis in goats. *Nepalese Veterinary Journal*. 2017;34:69-84.
- Sivaseelan S, Srinivasan P, Balachandran P, Vijayakumar S, Poomathi K. Pathology of Paucibacillary paratuberculosis in goats. *Indian Veterinary Journal*. 2011;88(8):103-105.
- Soulsby EJ. *Helminthes, Arthropods and Protozoa of Domesticated Animals*. 7th ed. London: Bailliere Tindal; 1982. p. 213-45.
- Sushma, Nehra V, Lather D. Aetio-pathological studies of digestive and respiratory affections in buffalo calves. *Haryana Veterinarian*. 2016;55(2):170-175.
- Tiwari AN, Jakhar KK, Sharma V, Jangir BL. Pathomorphological studies in goats affected with

- gastrointestinal tract disorders. The Pharma Innovation Journal. 2018;7(3):157-160.
30. Uzal FA, Plattner BL, Hostetter JM. Alimentary system. In: Jubb, Kennedy and Palmer's Pathology of Domestic Animals. 6th ed. Elsevier; 2015;2:1-257.
 31. Zachary JF, McGavin MD. Pathologic Basis of Veterinary Disease. 5th ed. Elsevier; c2012. p. 172-173, 385-387.