Journal of Animal Research: v.5 n.2, p. 359-372. June 2015

DOI Number: 10.5958/2277-940X.2015.00062.5

Clinical and Rumen Fluid Evaluation of Ruminal Disorders in Cattle

Mulat Asrat[1], Murali Manohar[2] and Samrawit Melkamu[3]

[1]Faculty of Veterinary Medicine, University of Gondar, ETHIOPIA
[2]Department of Clinical Studies, Faculty of Veterinary Medicine, ETHIOPIA
[3]Faculty of Veterinary Medicine, Samara University, ETHIOPIA

Corresponding author: M Asrat; Email: mullur1974@gmail.com

Received: 20 October, 2014 **Accepted:** 02 June, 2015

ABSTRACT

Clinical and rumen fluid changes in various ruminal disorders were studied clinically in 13 cattle at University of Gondar veterinary clinic, Gondar town, Ethiopia from September 2013 to May 2014. History, clinical signs, physiological and rumen fluid parameters were studied in all the cattle. The comparisons of the means between different stages of physiological parameters of different ruminal disorders were determined by repeated measure ANOVA to evaluate pre and post rumenotomy changes. The predominant clinical observations were, abdominal distension in non potential foreign bodies; grunt with bruxism in potential foreign bodies; bloat along with colic signs in ruminal tympany; and fluid splashing sound with palpable mass in the rumen in ruminal impaction. Poor quality roughage and excess concentrate were found to be the predisposing factors in ruminal disorders. In physiological parameters significant increase in temperature and decrease in rumen motility from the presurgical values up to 24 hrs and 48 hrs after rumenotomy were observed. Heart, pulse and respiratory rates revealed none significant changes between pre and post surgical intervals. The rumen fluid of cattle with different ruminal disorders on analysis before rumenotomy showed brownish colour, watery consistency, aromatic odour, pH range 4.9-8.0, increased MBRT and sedimentation activity time in most of the cases.

Keywords*:* Cattle, clinical, ruminal disorders, rumen fluid.

Surgical affections of the ruminant fore stomach due to ingested foreign bodies are the subject of attention almost all over the world and of major economic importance due to sever loss of production and production ability. Majority of the surgical maladies of the gastrointestinal tract like ruminal tympany, ruminal impaction, diaphragmatic hernia, traumatic reticulitis, abomasal impaction, intussusception, caecal dilatation are the multifactorial etiology constitute the most common cause for surgical gastrointestinal disorders in dairy cattle (Makhdoomi *et al.*, 1995). Rapid urbanization, industrialization and acute mineral deficiencies are the common causes for foreign body ingestion in ruminants in addition to their more frequent exposure to adult cattle (Dabas *et al.*, 2010). The physical form of the diet such as a reduction in the forage particle size or the processing of grain decreases ruminal pH. This response reflects less saliva production and more rapid breakdown of carbohydrates in the rumen (Krause and Combs, 2002). Indiscriminate feeding habit of cattle coupled with insufficient feeding by the owner force the animal to eat undigestible foreign material (Tripathi *et al.*, 2010). An average age of affection in cattle is below five years and trichobezoar has been associated with acute rumen tympany in calves and young cattle (Sharma *et al.*, 2003). The increase in the intra-abdominal pressure due to the pregnancy and ruminal tympany facilitates the penetration of the foreign bodies into the reticular wall and other abdominal and thoracic organs in cattle (Saini *et al.*, 2001).

Traumatic reticuloperitonitis (TRP) is relatively common disease in adult cattle caused by the ingestion and migration

of a foreign body in the reticulum. The influencing factors of TRP include remodelling of livestock housing, careless handling of baling wires, pins, feed sack bags and wires and using old buildings sites for hay storage. The incidence is more in females than males shortly after calving (Schipper, 2000). Cattle with traumatic reticulopericarditis shows the clinical signs of chronic indigestion, pyrexia, partial anorexia, laboured breathing, absence or reduced rumen motility, grunting, weight loss, colic signs and a positive reaction to foreign body test (Braun, 2007). Sudden ingestion of large amount of easily digestible carbohydrates or grain acts as predisposing factors of ruminal acidosis (Beauchemin and Penner, 2009). The acute acidosis often results in death, although illness and liver abscesses may proceed. Affected cattle may become depressed, go off feed and may have elevated heart rate or diarrhoea (Krause, and Oetzel, 2006). Fluid splashing sound is due to accumulation of ingesta in the obstructed intestinal segment resulting in upward floating of loops near the paralumbar fossa (Abutarbush and Naylor, 2006). Indigestible foreign body ruminal impaction are clinically characterized by pale mucous membrane, complete cessation of rumination, rumen impaction, atony, reduction of rumen motility, scanty faeces and inappetance (Roth and king, 1991). The indigestible material increases rumen motility and entangles to form a big lump posing difficulty in eructation, resulting in chronic recurrent tympany in cattle (Dutta *et al.*, 1988).

Significant increase in body temperature after rumenotomy in cattle is due to post operative inflammation and a slight elevation of temperature is a supportive clinical evidence of the presence of a chronic inflammation (due to healing process) and in severe case of acidosis in cattle (Cavedo *et al.*, 2004). The increase in respiratory and reduction in heart rate after rumenotomy in cattle is due to the toxic effects of lactic acid, reduced plasma volume and surgical stress (Radostits *et al.*, 2000; Ram *et al.*, 2007). Rumen fluid is the mixture of all fluids present in rumen chamber as a consequence of digestive processes and ingestion. The ingested fluids are saliva, water and mucus mixed with all the digestive components (Fubini and Ducharme, 2004). The colour of rumen fluid of cattle varies according to feeding. Abnormal colours include milky grey in acidosis and greenish-black when prolonged stasis and decomposition of food occurs within the fore stomachs of cattle and milky colour of ruminal fluid with rumen acidosis (Jasmin *et al.*, 2011; Navarre *et al.*, 2012). In ruminal acidosis, the rumen fluid is milky gray, acidic with pH < 5.5 and the protozoal population is either decreased or absent. The lower ruminal pH occurs when processed concentrate is fed in large quantities to cattle (Navarre *et al.*, 2012; Owens *et al.*, 1998). Alkaline pH is important diagnostic tool in field condition for early detection of plastic indigestion in bovine. An increase in the Methylene blue reduction test in cattle indicates impaction of rumen due to plastics (Boodur *et al.*, 2010; Dakshinkar, 2005). Age, sex and feed resources are the risk factors of foreign body rumen impaction in ruminants. The clinical and economic significance of foreign body rumen impaction causes to severe loss of production and high mortality (Ismael *et al.*, 2007; Radostits *et al.*, 2007). Therefore, early diagnosis and prompt surgical intervention not only reduce the economic loss but also save life of the animal. Hence present research project was undertaken with the aim to study the clinical changes and ruminal fluid dysfunctions in ruminal disorders in cattle.

MATERIALS AND METHODS

Location and selection of animals

The study was conducted in University of Gondar veterinary clinic, Gondar. The study material included cattle of different breed, age and sex which were brought for various surgical disorders of rumen from September 2013 to May 2014. Routine clinical examination was carried out in all the animals and consent was obtained from the patient owners for surgical interventions. The ruminal disorders were recorded based on age, sex, breed and pregnancy status in all the cattle. Age was grouped as cattle <5 years and >5 years. Sex was categorized as male and female. The breed was classified as non- descriptive and cross breed. The pregnancy status was recorded as pregnant and non pregnant cattle.

Anamnesis

A detailed history of feed intake, type of feed, any recent change in feed, defecation status, tympany, symptoms of regurgitation and rumination status were recorded.

Clinical signs

The predominant clinical signs such as abdominal distension, bloat, grunt, ruminal impactions and grinding of teeth were recorded in all the cattle.

Physiological parameters

The rectal temperature, respiratory rate, heart rate, pulse rate and rumen motility were recorded before, 24 hrs and 48 hrs after rumenotomy in all the cattle. The rectal temperature (ºC) was recorded using a clinical thermometer. The respiratory rate in breaths per minute and heart rate in beats per minute were recorded by stethoscope for employing vital signs. The pulse rate by palpation of coccygeal artery in beats per minute was recorded. The ruminal motility was recorded by pressing fist on left lower paralumbar fossa and motility per two minute was recorded.

Rumen fluid parameters

Rumen liquor samples were collected two hours before rumenotomy using modified rumen fluid suction (Fig.. 4). The first few pumps of fluid were discarded during collection to avoid contamination from saliva. A suction pump was used to withdraw about 200 ml of rumen fluid which was immediately evaluated for physical characters, chemical characters and microscopic examination for protozoa before rumenotomy in all the cattle.

Physical characters

The rumen fluid was immediately examined after collection with regard to colour, odour, and consistency. The sedimentation activity tests were also carried out by pouring a sample of rumen fluid in to a test tube and allowed to stand. The time (minutes) was measured for completion of sedimentation of fine particles and flotation of coarse solid particles.

Chemical characters

The pH of rumen liquor sample using universal pH papers indicator immediately after collection were evaluated. A small amount of rumen fluid was poured in to a test tube up the brim of the tube and a litmus paper was inserted until sufficiently wetted by the sample. The indicator paper was removed and the colour change was matched with standards of the indicator (Beauchemin and Penner, 2009; Dakshinkar, 2005). Cellulose digestion test was carried out as per method described by (Rosenberger *et al.*, 1979). The test tube was filled with 10 ml of rumen fluid and 0.3 ml of 16 % glucose was added. A cotton (cellulose) thread was weighted with a glass bead at the lower end. The glass bead was hung in to the tube containing rumen liquor so that its portion immersed in to fluid and fine end of thread fixed at the rim with a matter snipped. It was incubated at 39°C and the time in hours required for the thread to be snapped and bead dropped at the bottom of the tube was recorded. Methylene blue reduction time was estimated by transferring 20 ml of rumen fluid in to a sterile glass blood collection tube and mixing with 1 ml of 0.03 % methylene blue (Fubini and Ducharme, 2004). The mixed sample with test tube was allowed to stand at room temperature. The time in minutes needed for the colour of the mixture to change was recorded as methylene blue reduction time (Boodur *et al.*, 2010). The glucose fermentation test was carried out as the per the method described by (Roth and king,1991), 10 ml of rumen fluid mixed with 0.5 ml of 16 % glucose solution kept at 39 °C. The time in minute for gas formation was recorded.

Microscopic examination of protozoa

Protozoal activity was examined by placing one drop of fresh ruminal fluid on a pre warmed microscope slide and a cover slip was place. It was examined under low power objective of magnifying microscope. Protozoan motility was graded in four categories: ++++ Good : >10 mobile protozoa per field; +++ fair: 6-9 mobile protozoa per field; ++ subnormal: 3-5 mobile protozoa per field; + very low: <3 mobile protozoa per field (Rosenberger *et al.*, 1979).

Statistical analysis

The obtained data were stored in Microsoft excel-2007 and analyzed by using STATA 11. The mean and standard error were calculated to describe the variables. Comparisons of physiological parameters between different stages (before, 24 hrs and 48 hrs after surgery) in all cattle managed under rumenotomy were compared using repeated measure ANOVA. A simple contrast was used in which the 24 hrs and 48 hrs after surgery were compared with the before surgery parameters. Those differences with p value

<0.05 were considered statistically significant and those differences with p value <0.01 were considered as highly significance.

RESULTS

Thirteen cattle suffering from major ruminal disorders were underwent rumenotomy at UOG veterinary clinic during September 2013 to May 2014. All the cattle were subjected to routine clinical examination.

Animals Selection

The details of age, sex, breed and pregnancy status of the cattle selected for the study were presented in Table 1. Out of thirteen cattle selected for rumenotomy observation four were males of which 2 were below 5 years and 2 above 5 years. The remaining nine were females of which 3 were below 5 years and 6 above 5 years.

Table 1. Age, sex, breed and pregnancy status of cattle with ruminal disorders

Age (Yeats)	Sex	Breed	Pregnancy status
<5 years (n=5)	Male(n= 4)	Non-descript (n= 4)	>5 months Pregnant (n= 2)
>5 years (n= 8)	Female (n=9)	Cross(n= 9)	Non pregnant (n= 7)

Anamnesis

Out of thirteen cattle with ruminal disorders, three totally with totally anorectic and four with partially anorectic; six with ruminoreticular tympany; four with scanty faeces; three exhibited colic signs; five with laboured breathing (Table 2). Based on the feeding history, 4 fed with hay and concentrate, 4 with hay and grain, 1 with hay and straw, 1 with hay, concentrate and grain and 3 with hay, concentrate and straw (Table 3).

Clinical signs and observations

Out of thirteen cattle with ruminal disorders, 11 cattle elicited abdominal distension of which left flank (n=8) and right flank (n=3); five with bloat; seven with grunt; ten with ruminal impaction; eight with grinding of teeth (bruxism). Auscultation was revealed fluid splashing sound on left paralumbar fossa was evident in three cattle (Table 4). In ruminal tympany, the predominant signs recorded were ruminal distension, atony, bloat, bruxism, colic signs and laboured breathing. Profuse and malodorous diarrhoea with soft to liquid faeces, shallow and rapid respirations, increased heart rate, absence of primary ruminal contraction and high distensions of left paralumbar fossa (Fig. 1) were the predominant signs for diagnosis of lactic acidosis. In animals with non potential foreign bodies predominant signs recorded were abdominal distension, mild grunt and partial or complete anorexia. The predominant signs for the early diagnosis of the traumatic reticulitis were grunt, ruminal impaction bruxism, reluctance to move, scanty faeces, tachypnea, an arched stance with abducted elbows and brisket oedema (Fig. 2). In animals with ruminal impaction (Fig. 3), the predominant signs recorded were fluid splashing sound with palpable mass in the rumen and scanty faeces.

Table 2. Anamnesis in cattle with ruminal disorders

Case No.	Anorexia	Reticulo-ruminal tympany	Scanty faces	Colic signs	Laboured breathing
01	✓				
02		✓			✓
03		✓		✓	✓
04	✓		✓		
05	✓	✓			
06	✓				
07		✓			✓
08			✓		
09	✓		✓	✓	
010		✓			✓
011	✓				
012			✓		
013	✓	✓		✓	✓

Table 3. Type of feed given to cattle with ruminal disorder

Case No.	Type of feeding			
	Hay	Concentrate	Grain	Straw
01	✓	✓		
02	✓			✓
03	✓	✓		
04	✓		✓	✓
05	✓	✓		
06	✓	✓		
07	✓		✓	
08	✓	✓		
09	✓		✓	✓
010	✓	✓		
011	✓	✓	✓	
012	✓	✓		✓
013	✓		✓	

Physiological parameters

The mean (± S.E) of rectal temperature (ºC) before, 24 hrs and 48 hrs after rumenotomy in all cattle were 37.4 ± 0.11, 38±0.15 and 39.5 ± 0.16, respectively (Table 5). The mean body temperature indicated a significant ($P<0.05$) increase from the presurgical values up to 24 hrs. However, a highly significant ($p<0.01$) increase was recorded from presurgical values up to 48 hrs in all the cattle after rumenotomy. The mean (±S.E) of respiratory rate (per minute) before, 24 hrs and 48 hrs after rumenotomy in all cattle were 22.8 ± 4.33, 23.5 ± 3.12 and 26.3 ± 6.26, respectively (Table 5). The mean respiration revealed a non significant increase from the presurgical values up to 24 hrs and 48 hrs in all cattle after rumenotomy. The mean (±S.E) of heart rate (per minute) before, 24 hrs and 48 hrs after rumenotomy in all cattle were 77.3 ± 14.96, 78.8 ± 22.75 and 83.6 ± 16.41, respectively (Table 5). The mean values of heart rate indicated a non significant increase from the presurgical values up to 24 hrs and 48 hrs in all the cattle after rumenotomy. The mean ± (S.E) pulse rate per minute by palpation in coccygeal artery was recorded before, 24 hrs and 48 hrs after rumenotomy in all animals were 78.9 ± 13.41, 82.7 ± 10.86 and 85.0 ± 21.72, respectively (Table 5). The mean values of pulse rate indicated a non significant increase from the presurgical

Table 4. Clinical signs observed in cattle with ruminal disorders

Case No.	Distended abdomen	Bloat	Grunt	Ruminal impaction	Fluid splashing sounds	Grinding of teeth
01		✓		✓		✓
02	✓		✓	✓		
03	✓	✓		✓		✓
04			✓		✓	✓
05	✓			✓		
06	✓		✓	✓		✓
07	✓		✓	✓		✓
08	✓	✓		✓	✓	
09	✓		✓	✓		
010	✓		✓			✓
011	✓		✓	✓		✓
012	✓	✓		✓	✓	
013	✓	✓				✓

Figure 1. Distended paralumbar fossa in ruminal acidosis

Figure 2. Cattle with acute traumatic reticulitis showing brisket oedema (arrow)

Figure 3. Rectal examination of rumen impaction

Figure 4. Modified rumen fluid suction

values up to 24 hrs and 48 hrs in all the cattle after rumenotomy. The mean (±S.E) rumen motility per two minute before, 24 hrs and 48 hrs after rumenotomy were 1.6 ± 0.07, 1.1 ± 0.18 and 0.6±0.11, respectively (Table 5). The mean rumen motility indicated a highly significant ($P<0.01$) decreased from the presurgical values up to 48 hrs. However, a non significant reduction in rumen motility was found from presurgical values up to 24 hrs in all the cattle after rumenotomy.

Table 5. The mean (± S.E) values of physiological parameters observed in cattle before and after rumenotomy

Physiological parameters	Before Surgery	24 hrs after surgery	48 hrs after surgery
Rectal temperature (°C)	37.4 ± 0.11[a]	38.0±0.15[b]	39.5 ± 0.16[b]
Respiration rate (per min.)	22.8± 4.33	23.5±3.12	26.3± 6.26
Heart rate (per minute)	77.3±14.96	78.8± 22.75	83.6± 16.41
Pulse rate (per minute)	78.9±13.41	82.7±10.86	85.0±21.72
Rumen motility (per 2 min)	1.6 ±0.07[a]	1.1± 0.18[b]	0.6±0.11[b]

[a, b]Mean bearing different superscript in a row differs significantly.

Rumen fluid analysis

Physical characteristics

Out of thirteen cattle with ruminal disorders, the colour of rumen fluid was brownish green, yellowish brown, greenish and milky in 5, 4, 3 and 1 respectively (Table 6). The predominant colour of greenish brown and yellowish brown was noticed in the cattle fed with hay and grain rations. The consistency of rumen fluid out of thirteen cattle, viscous was observed in four cattle, watery in six cases and frothy in three cases with different ruminal disorders (Table 6). Of the 13 cattle, aromatic odour was obtained in 8 cases and sour odour in 5 cases (Table 6). The rumen fluids collected from 13 cattle were examined for sedimentation activity. Sedimentation activity less

Table 6. Results of rumen fluid examination for physical characteristics before rumenotomy in cattle

Case No.	Colour			Consistency				Odour		SAT		
	BG	YB	G	M	V	W	F	Ar	S	≤3 min.	4-8 min.	No sed/ flot
01		✓			✓			✓			✓	
02			✓			✓		✓		✓		
03				✓			✓		✓	✓		
04	✓				✓			✓		✓		
05	✓					✓		✓				✓
06		✓				✓	✓	✓		✓		
07		✓							✓		✓	
08	✓					✓			✓			✓
09		✓			✓			✓		✓		
010	✓					✓			✓	✓		
011	✓						✓		✓			✓
012			✓		✓			✓			✓	
013			✓			✓		✓		✓		

BG..... Brownish green
V.....Viscous
Ar.....Aromatic
YB.....Yellowish brown
M.....Milky
G.....Green
W.....Watery
S.....Sour
F.....Frothy
SAT.....Sedimentation activity test
No Sed /flot.....No sedimentation or flotation

than 3 minute was observed in 7 animals, 4-8 minute in 3 animals and no appreciable sedimentation or floatation was observed in another 3 animals (Table 6).

Chemical characteristics

Out of thirteen animals with ruminal disorders, rumen fluid pH varied from 4.9 to 8.0. The acidic pH 4.9-5.5 was recorded in 6 cattle, normal pH 6-7 in 4 cattle and alkaline pH 7.6 - 8.0 in 3 cattle (Table 7). The pH values of the rumen fluid recorded were mostly in acidic value of 4.9-5.5 in cattle fed with hay and concentrate feeding schedule. Out of thirteen animals with ruminal disorders, cellulose digestion time was noticed within 48-56 hrs in 4 cattle and digested till 56 hrs in 9 animals (Table 7). Out of thirteen animals with ruminal disorders, the Methylene blue reduction time (MBRT) was noticed within 3 min. in 5 cattle, and it was delayed up to less than 6 min. in 4 cattle and more than 6 min. in 4 (Table 7). Out of thirteen animals with ruminal disorders, glucose fermentation time with gas formation of 1-2 ml per hour was observed in 4 cattle, little gas formation in 4 animals and no gas formation in 5 animals (Table 7).

Microscopic examination of protozoa

Protozoan motility was fair (+++) in 3 cattle, subnormal (++) in 4 and very low (+) in remaining 6 (Table 7).

Table 7. Results of rumen fluid examination for chemical characters and microscopic examination for protozoan activity before rumenotomy in cattle

Case No.	pH	CDT			MBRT		GFT			Motility		
		Within 48-56 hrs	>56 hrs	≤ 3min	<6 min	>6 min	1-2	Little	No	+++	++	+
01	5.0	✓			✓		✓				✓	
02	8.0		✓		✓			✓		✓		
03	5.3		✓			✓	✓				✓	
04	6.5		✓	✓	✓			✓				✓
05	6.4	✓		✓					✓		✓	
06	5.4		✓			✓			✓			✓
07	8.0	✓					✓				✓	
08	5.2		✓	✓				✓		✓		
09	7.6	✓				✓	✓					✓
010	5.4		✓						✓			✓
011	6.8		✓	✓		✓			✓			✓
012	4.9		✓	✓					✓	✓		
013	6.0		✓		✓			✓				✓

CDT.....Cellulose digestion test
GFT.....Glucose fermentation time
MBRT.....Methylene blue reduction time
+++..... Fair: 6-9 mobile protozoa per field
++ ..... Subnormal: 3-5 mobile protozoa per field
+ ..... Very low: <3 mobile protozoa per field

DISCUSSION

The ruminal disorders observed in all thirteen cattle were discussed with regard to animal selection, anamnesis, clinical signs and symptoms, physiological and rumen fluid parameters. Ruminal disorders were detected mostly in cattle aged more than five years which was in agreement with earlier reports of (Ismael *et al.*, 2007; Kahn, 2005; Ram *et al.*, 2007). However, the present study contradicts with earlier reports of (Sharma *et al.*, 2003) who reported average age of affection in cattle as below five years and trichobezoar have been found associated with acute rumen tympany in calves and young cattle. The higher ruminal disorders in cattle aged more than 5 years in the present study could be due to difference in feeding practices and their more exposure through time as many cattle were found accumulate in their rumen and to be positive. In the present study ruminal disorders were found mostly in females than males. Similar occurrence of ruminal disorders in females have been reported by earlier workers (Schipper, 2000; Vanitha *et al.*, 2010). The higher occurrence of ruminal disorders in females observed in the present study could be due to the increased appetite of female animals to meet the nutritional demands during pregnancy and lactation. In the present study ruminal disorders were seen mostly in cross breeds than nondescript. Similar occurrence of ruminal disorders in cross breeds have been reported by (Roth and king, 1991). The higher occurrence of ruminal disorders in cross bred in the present study could be due to the fact that Holstein Friesian cross bred cattle were introduced for increased production of milk (females) and the owner's poor feeding management caused nutritional deficiency and pica behaviours which obviously led to the consumption of all sorts of foreign bodies which come across in the grazing areas.

In the present study cattle affected by ruminal disorders were found mostly in non pregnant cattle than pregnant ones. On the contrary (Saini *et al.*, 2001) opined that the intra-abdominal pressure due to pregnancy and ruminal tympany might facilitate the penetration of the foreign bodies into the reticular wall and other abdominal and thoracic organs in ruminants. The higher number of ruminal disorders in non pregnant cattle in the present study could be due to poor feeding management. Anorexia was reported in the present study. Similar findings were also reported by (Krause and Oetzel, 2006; Kumar *et al.*, 2003). The excessive built-up of short chained fatty acids in ruminal fluid increased the osmolarity of rumen contents which inturn inhibits feed intake, salivation, and the onset of rumination following meals (Carter and Grovum., 1990) was in accordance with the present findings. The off feeding condition could be due to reduced motility of stomach and intestine that might have resulted from neurological and functional disturbance, inflammation, grain over loading and mechanical obstruction.

In the present study the most common clinical findings in cattle suffering from different ruminal disorders was recurrent rumen tympany which was in accordance with the findings of (Radostits *et al.*, 2000; Reddy *et al.*, 2004; Sattler *et al.*, 2000) also reported that recurrent rumen tympany was frequently a sign of digestive disease in young calves which resulted from accumulation of free gas in the reticulorumen and commonly associated with vagal indigestion in adult dairy cattle. The ruminal tympany observed in the present study could be due to the factors like failure of eructation mechanism, traumatic reticuloperitonitis, motility disorders, mechanical and functional obstructions. In the present study of animals with ruminal disorder passing off scanty faeces was observed. This condition results from the accumulation of the indigestible materials in the rumen which interferes with the flow of ingesta. Similar findings were also reported by Remi-Adewunmi *et al.* (2004); Vanitha *et al.* (2010). The passing off scanty faeces recorded in the present study could be the result of stopover of ingesta was not obstructed completely.

Colic signs were observed in animals with different ruminal disorders in the present study. Braun (2003) reported similar clinical signs of colic in bovine suffering from intestinal obstruction. They were characterized by forceful kicking at belly with hind legs, frequent sitting and standing up, paddling of limbs, stretching in recumbency and arching of back. The colic signs recorded in the present study could be the result of mechanical and functional obstructions due to the distension of gastrointestinal tract. In animals with different ruminal disorders laboured breathing was observed in the present study. Similar observation was recorded by Braun (2003). The increased breathing was attributed to the increased rumen load, which could have caused increased trans-diaphragmatic pressure. Rumen fermentation disorders were typically traced to diets with excessive levels of concentrates along with regular feeding schedule and highly fermentable carbohydrates as described by (Beauchemin, and Penner; Tripathi *et al.*,

2010). Similar findings were also reported by Ducharme (1990); Khose *et al.* (2010); Ramprabhu *et al.* (2003) who stated the habit of eating non-edible foreign materials was due to mineral deficiency, un-organized small-scale farming and poor standard in animal management and feeding. The present study confirmed that the poor standard in animal management and feeding, poor farming strategy of the livestock owners, easy access to vegetable wastes in polythene bags, lack of the availability of fodder, poor quality roughage and grain overload were the causative factors for ruminal disorders. In the present study distended abdomens were noticed with different ruminal a disorders. Ismael *et al.* (2007); Wilson and Ferguson (1984) recorded similar findings of distended abdomen in cattle reared in urban and sub-urban environments. Furthermore, abdominal distension due to phytobezoar have also been described in ram, buffalo, cattle and giraffe by (Abutarbush. and Naylor, 2006; Davis *et al.*, 2009). There was a strong correlation between occurrence of recurrent bloat in cattle involved in this study and was exhibited by the abdominal bulging of the paralumbar fossa on the left of abdominal and the presence of non-metallic foreign bodies in this study could have been due to the presence of large amounts of these materials in the reticulorumen which could have caused over stretching and distension of these structures leading eventually to its fatigue. This is in accordance with the findings of Garry and Smith (2000); Schweizer *et al.* (2005) who were of opinion that in adult animals, free-gas bloat is less frequent and usually more acute because disturbances of the adult rumen tend to be more rapid and severe. Similar findings correlated with earlier investigations by (Schwartzkopf-Genswein *et al.*, 2004) in addition, reported that the risk of feedlot bloat increases when rapid changes occur in diet composition or in feed delivery that increases the supply of rapidly fermented carbohydrate. The bloat could be attributed to factors like ruminal acidosis, diaphragmatic hernia, vagal indigestion, mechanical obstruction due to trichobezoars, phytobezoars, impacted feed materials, ingestion of plastic bags or papers and traumatic reticuloperitonitis. In the present study bloat could be related to lack of coarse roughage in the diet to induce eructation. In the present study grunt were noticed with different ruminal disorders in cattle. Similar findings were reported by (Braun *et al.*, 2007). The grunt could be due to visceral pain by traumatic reticulopericarditis, over distension of rumen and reticulum. In this study, the majority of cattle were found to have impacted rumen contents and this could be due to eating of plastic ropes or leather pieces which interfaces with the flow of ingesta and poor quality roughage. Similar findings were reported by (Ducharme, 1990; Herzog *et al.*, 2004). The ruminal distension, ruminal atony, hard and infrequent faeces, arching of back, rigidity of stance and a loud frequent moaning grunt in cases of rumen impaction recorded in the present study were in accordance with the findings of (Pattanaik and Das, 1999). In the present study the rumen impaction could be recognized to a condition which resulted from the accumulation of the indigestible materials in the rumen with interfaces which the flow of ingesta leading to distension of the rumen and passing of scanty or no faeces.

Fluid splashing sound on left paralumbar fossa was evident in cattle with ruminal affections. This finding were in accordance with Abutarbush *et al.* (2006); Radostits *et al.* (2000) who were of the opinion that the fluid splashing sound could have arisen from the accumulation of ingesta in the obstructed intestinal segment resulting in upward floating of loops near the paralumbar fossa. The excessive grinding of the teeth (bruxism) was clinically manifested by patient's suspected different ruminal disorders could be a result of the induction of pain.

Respiratory distress with laboured breathing, increased heart and pulse rate recorded in the present study could be due to the build up of great pressure over the diaphragm as a result of foreign bodies' lodgement, over intake of grains, ruminal impactions. The predominant signs of ruminal impaction were ruminal impaction, fluid splashing sound and scanty faeces in the present study was in accordance with the findings of (Rosenberger *et al.*, 1979).A significant increase in the mean body temperature was noticed at 24 hrs and 48 hrs after rumenotomy indicating a systemic reaction. This was in accordance with the reports of Balkc and Gunay (2004) and Dehghani and Ghadrdani (1995) where the authors reported increased mean body temperature after rumenotomy. The present finding was similar to the earlier authors as Cavedo *et al.* (2004) and Radostits *et al.* (2000) who reported persistent slightly elevated temperature which was supportive evidence of the presences of a chronic inflammation, severe case of acidosis, and in some animals exposed to the sun in hot weather. On the contrary Nour *et al.* (1998) reported that the decreased level of rectal temperature which was due to lactic acidosis, leading to dehydration; fall in total plasma

volume and severe depression of cardiovascular system. In the present study rise of the mean body temperature after performing surgery could be attributed to the stimulation of the thermoregulatory mechanism in the hypothalamic centre with haemodynamic changes during the surgical procedure, severe pain, muscular weakness and other inflammatory changes associated with the surgery. In the present study no significant change in the respiratory rates were observed in all the animals with ruminal disorders. There was significant increase in respirations which was shallow and rapid and increased. Similar increase in respiratory rates had been reported by (Saini *et al.*, 2001) in acidotic cattle. The observed increase in the respiratory rate indicated respiratory distress associated with toxemia and septicaemia caused by the foreign body penetration. Increased heart rate and pulse rate in animals suffering from ruminal affection had been recorded in the present study. This was in agreement with Dehghani and Ghadrdani (1995) and Krause and Oetzel (2006) who reported a rapid beating of the heart, abnormally fast breathing following an acute acidosis. On contrary, the reduction in the heart rate and the pulse rate after performing surgery in this study could be due to the toxic effects of lactic acid, reduced plasma volume and surgical stress encountered (Radostits *et al.*, 2007). The present study revealed a decrease in the rumen motility after surgical procedure, up to 48h. These values in the present study agreed with Braun (2003); Reddy *et al.* (2004) and Tripathi *et al.* (2010) who reported that indigestible material in cattle increased rumen motility before becoming atonic in the post surgical period. Ruminal movements were markedly depressed compared to ruminal movements in the clinically healthy cows (3 movements/2 min), indicating significant hypomotility of the rumen in the cows with foreign body syndrome (Radostits *et al.*, 2007) which was confirmed in this study. A decrease in rumen motility in the present study might be due to the surgical incision and suturing of tissues followed by inflammation, which results in a decrease in rumination and less production of saliva which contains high concentrations of bicarbonate ions as an important buffering mechanism for the rumen after rumenotomy.

Colour of rumen fluid of cattle varied according to their feeding management (Rosenberger *et al.*, 1979). In most of the cases remarkable changes in the characteristics of ruminal fluid as brownish green were observed. On the other hand Jasmin *et al.* (2011) who reported ruminal changes were milky colour to events observed in sheep with rumen acidosis. The predominant brownish green colour observed could be due to the fact that most cattle were fed with hay ration. In most of the cases a remarkable change in the characteristics of ruminal fluid as watery colour was observed. This finding was in agreement with Fubini and Ducharme (2004) who reported that rumen fluid was the mixture of saliva, water and mucus mixed with all the digestive components. The prime watery consistency characteristics could be due to the presence of inactive microflora related to the foreign body syndromes which disrupt the bacteria and protozoa.

In most of the cases, remarkable change in the odour characteristics of ruminal fluid as aromatic odour. Similar results were observed by (Rosenberger *et al.*, 1979). The predominant aromatic odour characteristics could be due to the fact that most causes of different ruminal disorders were related to intake of cattle feed. There were no published literatures available on sedimentation activity test for comparison of results of the present study. Sedimentation activity test directly determine the microfloral activity. The results of the present study with very rapid sedimentation to no floatation could be related to the prolonged anorexia, rumen acidosis and inactive microflora. In the present study pH of the rumen fluid ranged from 4.9 to 8.0. A ruminal pH of 4.9 to 5.5 suggests a marginal or developing problem of ruminal acidosis which was almost similar to findings of Krause and Oetzel (2006); Nagaraja and Titgemeyer (2007) and Plaizier *et al.*, 2008) who reported that ruminal pH ranged from 5.0-6.16 in ruminal acidosis in beef cattle and dairy cows. The low pH in the present study could be related to main ingredient being concentrated in the ruminal contents which had mostly barley by-products which could be easily degraded in the rumen. Low rumen pH depresses cellulose digestion and intake of roughage, leading to problems of acidosis. A ruminal pH of 7.6 and above suggest a marginal or developing problem of ruminal alkalosis which was almost similar to findings of Boodur *et al.*(2010) and Dakshinkar (2005) who reported that alkaline pH could be important diagnostic tool in field condition for early detection of plastic indigestion cases. The increased range of ruminal fluid pH in the present study might be the presence of plastics, rags and ropes which probably contributed for the development of ruminal alkalosis. In the present study

cellulose digestion test of the rumen fluid required greater than 56 hours. This indicated the presence of partially inactive ruminal flora required for cellulose degradation. The rumen fluid with inactive microflora required for cellulose digestion was probably due to the presence of foreign bodies in the rumen resisting degradation of fibres there by changing the ruminal environment required for the survival and activity of these floras. In the present study the Methylene blue reduction time (MBRT) of less than 3 min was observed in cattle which received mixed ration of roughage and concentrates. Similar findings were reported by Boodur *et al.* (2010). However, MBRT of the rumen fluid in much of the cases required more than 3 min (delayed clearing) which was indicative of reduction in number of anaerobes. This was in accordance with Fubini and Ducharme (2004) who opined that delayed clearing of the dye indicated diminished anaerobic bacterial activity. The results of present study could be related to cattle fed with indigestible roughage, anorexia of several days and rumen acidosis. In the present study the glucose fermentation test in the ruminal fluids resulted in little or no gas formation indicating that there was a drastic reduction in the population of bacteria required for glucose fermentation. The normal rate of gas formation was 1-2 ml per hour and little or no gas formation indicates inactive microflora. In foamy bloat gas was formed with pronouncing foaming. In the present study the protozoal activity was graded from ++++ to +. However, the results indicated that the protozoal activity in this study ranged from +++ to +. The lower motility and reduction in number of protozoa were responsible for reduced grades of motility and protozoal activity observed and indicated that there was a disturbance in the ruminal environments. Dehority and Orpin (1997) and Franzolin and Dehority (1996) have reported that the concentration of protozoa in rumen contents generally increased with the addition of concentrates over roughage diets. The sluggish motility and low number of protozoa observed in the present study could also be attributed to factors like induced sub acute rumen acidosis, fall in the pH of rumen contents and underfeeding which could cause undesirable changes in microbial populations.

CONCLUSION

The predominant clinical observations were abdominal distension in non potential foreign bodies; grunt with bruxism in potential foreign bodies; bloat, bruxism along with colic signs in ruminal tympany and fluid splashing sound with palpable mass in the rumen in ruminal impaction. The higher ruminal disorders were noticed in female, cross breed, adult and non pregnant cows, aged above 5 years. Poor quality roughage and excess concentrate were found to be the predisposing factors in ruminal disorders of cattle. In physiological parameters significant increased temperature and decreased rumen motility from the presurgical values up to 24 hrs and 48 hrs after rumenotomy were observed. Heart, pulse and respiratory rates revealed no significant changes between pre and post surgical intervals. The rumen fluid of cattle with different ruminal disorders on analysis before rumenotomy showed brownish colour, watery consistency, aromatic odour, pH range 4.9-8.0, increased MBRT and sedimentation activity time in most of the cases.

Therefore, based on the above conclusions, the following recommendations are forwarded:

- ❒ Livestock owners should be cautioned against unsupervised grazing of cattle as there in danger of accidental ingestion of disposed vegetable waste/kitchen waste in plastic bags.
- ❒ Replenishing the rumen to restore the ruminal ecosystem and antimicrobials coverage to prevent possible infection should be taken into consideration.
- ❒ Keep away from unsupervised grazing of cattle as there in danger of accidental ingestion of disposed vegetable waste/kitchen waste in plastic bags.

REFERENCES

Abutarbush, S. and Naylor, J. 2006. Obstruction of the small intestine by a trichobezoar in cattle: 15 cases (1992–2002). *Am. Vet. Med. Assoc. J.,* **229**:1627-1630.

Balkc, E. and Gunay, C. 2004. Comparison of some clinical, haematological biochemical and electro cardiography findings before and after rumenotomy in cows with reticular peritonitis. Saglk-Bilimler –Dergisi, Firat – Universitesi – Veterinary, Pp. 13-19.

Beauchemin, K. and Penner, G. 2009. New developments in understanding ruminal acidosis in dairy cows. Tri-State Dairy Nutrition Conference, Pp. 1-12.

Boodur, P., Sivaprakash, B.V., Kasaralivar, V. and Rand D. D. 2010. Methylene blue reduction test in cattle affected with

rumen impaction due to plastics. *J. Ind. Poly Vet*., **11** (2): 184-188.

Braun, U. 2003. Ultrasonography in gastrointestinal disease in cattle. *Vet. J.,* **166**: 112-124.

Braun, U., Schewizer G. and Legune, B. 2007. Clinical findings of cattle with Traumatic Pericarditis, *Vet. Record.*, **161**: 558-563.

Carter, R. and Grovum. W. 1990. A review of the physiological significance of hypertonic body fluids on feed intake and ruminal function: salivation, motility and microbes. *Ani. Sci. J.*, **68**: 2811–2832.

Cavedo, A., Latimer, K., Tarply, H. and Bain, P. 2004. Traumatic reticuloperitonitis (hard ware diseases in cattle veterinary clinical pathology clerk ship program university of Georgia, Athens, p.1-4: In http: // www. Vet. Uga. Edu/ Vpp/ clerk / lave to index.

Dabas, V.S., Derashri, H.J. and Gohil, J.A. 2010. Accidental ingestion of gold necklace and its extraction from a Surti buffalo-a case report. *Intas Polivet*, **11**: 196.

Dakshinkar, M. P. 2005. Proceedings of the first round table conference on rumenology. Pp. 269 - 276.

Davis, M.R., Langan, J. N., Mylniczenko, D. N., Benson, k. and Lamberski, N. 2009. Colonic obstruction in three captive reticulated giraffe (Giraffa Camelopardalis reticulata). *Zoo and Wild Med. J.,* **40**:181-188.

Dehghani, S.N and Ghadrdani, A.M. 1995. Bovine rumenotomy: Comparision of four surgical techniques. *Cana. Vet. J.,* **36**: 693-697.

Dehority, B.A. and Orpin, C.G. 1997. Development of, and natural fluctuations in, rumen microbial populations. In: Hobson PN, Stewart CS (eds): The Rumen Microbial Ecosystem. Blackie Academic & Professional (Chapman & Hall), London, Pp.198-245.

Ducharme, N.G. 1990. Surgery of the bovine fore stomach compartments. *Vet. Clinic North Am. (Food Animal Practice),* **6**: 371- 397.

Dutta, J.C, Baruah, R.N., Dutta, L. and Talukdar, S.C. 1988. Blood biochemical studies in anoestrous and normal cyclic cattle. *Ind. Vet. J,* 65:239-241.

Franzolin, R. and Dehority, B.A. 1996. Effect of prolonged high concentrate feeding on ruminal protozoa concentrations. *An. Sci. J.,* **74**: 2803-2809.

Fubini, S.L. and Ducharme, N.G. 2004. Surgery of ruminant fore-stomach compartment. In Farm Animal Surgery. S.L. Fubini and N.G. Ducharme (Eds), Saunders, Elsevier, Pp. 161-240.

Garry, F. B. and Smith B.P. 2000. Indigestion in Ruminants. In: Large Animal Internal Medicine Mosby-Year Book, St. Louis, Missouri, Pp. 824-858.

Hawkins, L.L., 2002. Bovine Digestive Diseases In: Large Animal Digestive Diseases notes. LAMS 5350, Pp. 22-24.

Herzog, K., Kaske, M., Bischoff, C., Kehler, W., Hoeltershinken, M., Starke, A., Stober, M. and Rehage, J. 2004. Post surgical development of inflammatory adhesions and reticular function in cows suffering from traumatic reticuloperitonitis. *Dtsch Tierarztl Wochenschr*, **111**: 57-62.

Ismael, Z.B., Al-Majabi, A. and Al-Qudah, K. 2007. Clinical and surgical findings and outcome following rumenotomy in adult dairy cattle affected with recurrent rumen tympany associated with non-metallic foreign bodies, *Am. Ani. and Vet. Sci. J.,* **2:** 66-70.

Jasmin, B. H., Modesto, R. B. and Schaer, T. P. 2011. Perioperative Ruminal pH Changes in Domestic Sheep (Ovisaries) housed in a biomedical research setting, *Am. Assoc. Labo. Ani. Sci. J.*, **50(1):** 27-32.

Kahn, C.M. 2005. The Merck veterinary manual, 9th ed., USA, Merck and CO., INC., Pp. 186-188.

Khose, K.A, Jadhav, P.A. and Mahajan, V.E. 2010. Ruminal impaction in a cow with indigestible foreign bodies and its surgical management. *Intas Polivet*, **11 (2)**: 189-190.

Krause, K. M. and Combs, D. K. 2002. Effects of forage particle size and grain fermentability in mid lactation cows. II. Ruminal pH and Chewing Activity. *J. Dairy Sci.,* **85**: 1947-1957.

Krause, K. M. and Oetzel, G. R. 2006. Understanding and preventing sub acute ruminal acidosis in dairy herds: a review. *Anim Feed Sci. Tech.*, **126**: 215–236.

Kumar, R., Lakkawar, A.W., Nair, M. G. and Varshney, K.C. 2003. Gastrointestinal obstruction in cows. *Ind. Vet. J.,* **80**: 318-319.

Makhdoomi, D.M., Singh, A.P., Singh, M. and Krishnamurthy, D. 1995. Intestinal obstruction in ruminants: A review. *Ind. Vet. Surgery J.*, **16**: 81-82.

Nagaraja, T.G. and Titgemeyer, E.C. 2007. Ruminal acidosis in beef cattle: the current microbiological and nutritional outlook. *Dairy Sci. J,* **90**: 17-38.

Navarre, C.B., Baird, A. N. and Pugh, D. G. 2012. Diseases of the Gastrointestinal System. In: Pugh DG, Baird AN, eds. Sheep and Goat Medicine, 2nd ed. Maryland Heights, MO: Elsevier-Saunders, Pp. 71-105.

Nour, M.S., Abusamna N.T. and Hago B.E. 1998. Experimentally induced lactic acidosis in Nubian goats: clinical, biochemical and pathological investigations. *Small Ruminant Res*., **31**: 7-17.

Oetzel, G. 2000. Clinical aspects of ruminal acidosis in dairy cattle. The AABP Proceedings, **23**:46-53

Owens, F.N., Secrist, D.S., Hill, W.J. and Gill, D.R. 1998. Acidosis in Cattle: A Review. *Ani. Sci. J.,* **76**: 275-286.

Pattanaik, T.K. and Das, P. 1999. Ileus secondary to omasal impaction: A case report. *Ind. Vet. Surg*ery *J.*, **20**: 54.

Plaizier, J.C., Krause, D.O., Gozho, G.N. and McBride, B.W. 2008. Sub acute ruminal acidosis in dairy cows: the physiological causes, incidence and consequences. *Vet. J.*, **176**: 21-31.

Radostits, O. M., Gay, C.C., Blood, D.C. and Hinchcliff, K.W. 2000. Diseases of alimentary tract – II. In: Veterinary Medicine. 9th ed. Book Power Publishers, Philadelphia, U.S.A. Pp. 259-346.

Radostits, O.M., Gay, C.C., Hinchcliff, K.W. and Constable, P.D. 2007. Impaction of the omasum. Veterinary Medicine: A textbook of the diseases of cattle, horses, sheep, pigs and goats. 10th ed. Elsevier Health Sciences, Philadelphia, PA, USA, 352-353.

Ram, P. K., Verma, S.P. and Agrawal A.K. 2007. Effect of therapeutic measures on important clinical parameters in acidotic cattle. *Ind. Vet. Med J.,* **27:** 37-39.

Ramprabhu, R., Dhanpalan, P. and Prathaban, S. 2003. Comparative efficacy of diagnostic test in the diagnosis of TRP and allied syndrome in cattle. *Israel Veterinary Medicine Association*, **58**: 2-3.

Reddy, R. Y, Naidu, T. P, Viroji, S. T, and Syama, S. N. 2004. Foreign bodies in rumen and reticulum of punganur cattle. *Ind. Vet. J.*, **81:**1063.

Remi-Adewunmi, P.K., Jadhav, R.V., Dange, B. P. and Mehesare, T.A. 2004. Impaction of rumen with indigestible garbage in cattle reared within urban and suburban environment. *Nigerian Vet. J.,* **13**: 89-95.

Rosenberger, G., Dirksen, H.D. Grunder, E., Grunert, D., Krauze, M., and Mack, R. 1979. Clinical Examination of Cattle. 2nd ed. Verky Paulparay, Berlin, Humburg, Pp. 203-209.

Roth, L. and king, J.M. 1991. Traumatic reticulitis in cattle: a review of 60 fatal cases. *Vet. Diag. Invest. J.,* **3**: 52-54.

Saini, N.S., Sobti, V. K., Mirakhur, K. K., Singh, S.S., Singh, K.I., Bansal, P.S., Simran, S.S. and Bhatia, R. 2001. Survivors of diaphragmatic hernia in buffaloes (Bubalus bubalis). *Ind. Ani. Sci. J.,* **71**: 839-840.

Sattler, N., Fecteau, G., Hélie, P., Lapointe, J.M., Chouinard, L., Babkine, M., Desrochers, A., Couture, Y. and Dubreuil, P. 2000. Etiology, Forms and Prognosis of Gastrointestinal Dysfunction Resembling Vagal Indigestion Occurring after Surgical Correction of Right Abomasal Displacement. *Cana. Vet. J.,* **41:** 777-785.

Schipper, I.A. 2000. Lecture outline of Preventive Veterinary Medicine 6th ed., Surgeet Publishing, Pp. 166-167.

Schwartzkopf-Genswein, K. S., Beauchemin, K. A., McAllister, T. A., Gibb, D. J., Streeter, M. and Kennedy A. D. 2004. Effect of feed delivery fluctuations and feeding time on ruminal acidosis, growth performance, and feeding behavior of feedlot cattle. *Ani. Sci. J.,* **82**: 3357-3365.

Schweizer, G., Fluckiger, M., Metzger, L. and Braun, U. 2005. Ruminal Tympany due to a Trichobezoar in a Heifer. *Vet. Radiology Ultra*sonography, **46**: 500-501

Sharma, A., U., Kumar, A. G. and Ryot, K.D. 2003. Clinical observations in intestinal obstruction in cattle - a field study of 12 cases. *Ind. Vet. J.,* **80:**265-267.

Slatter, N., Fecteav, P., Helie, J., Lapointe, T., Choueinard, M., Babkine, A., Descrochers, Y., and Dubreni, P. 2000. Etiology, forms and prognosis of gastrointestinal dysfunction resetorbling vagal indigestion occurring after surgical correction of right abomasal displacement. *Cana. Vet. J.,* **41**:777-785.

Stone, W.C. 2004. Nutritional Approaches to Minimize Sub acute Ruminal Acidosis and Laminitis in Dairy Cattle. Journal of Dairy Science, **87**: P. E13-E26, ISSN 0022-0302.

Tripathi, A. K., Soodan, J.S., keeshawa. R. S. and Shamod, K. 2010. *Ind. Poly. Vet.,* **11(2)**:197-198.

Vanitha, V., Nambi, A. P., Gowri, B. and Kavitha, S. 2010. Rumen impaction cattle with indigestible foreign bodies. *Tamil Nadu S. Vet. Anim. Sci. J.***, 6:** 138-140.

Wilson, A.D. and Ferguson, J.G. 1984. Use of flexible fiberoptic laparoscope as a diagnostic tool in cattle. *Cana. Vet. J.,* **25**:229-234.