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Some Biochemical, Hematological and Clinical Studies of Selected Ruminal and Blood Constituents in Camels Affected by Various Diseases*

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Abstract: Selected ruminal and blood constituents were investigated in a group of 71 dromedary camels suffering from various diseases including Trypanosomiasis (n = 5), Mange (n = 4), Pasteurolesis (n = 10), contagious skin disease (n = 5), Inflammation of soft palate (n = 3), bloat (n = 4), indigestion (n = 10), Ruminal acidosis (n = 10) and normal camels (n = 20). Our investigations showed significant changes in ruminal pH, ruminal ammonia nitrogen, RVFA, ruminal calcium, sodium, potassium, RBCs, Hb, MCV, MCH, neutrophil %, eosinophil %, basophil %, serum total protein, albumin, urea, creatinine and uric acid in ruminal acidosis group. While in Trypanosomiasis, Pasteurolesis groups, there is changes in ruminal ammonia nitrogen, ruminal total protein, ruminal urea, ruminal calcium, potassium, inorganic phosphorus (only in trypanosomiasis) and ruminal Chloride, Eosinophil %, basophil %, serum total protein and albumin. But in indigestion group, changes in ruminal ammonia nitrogen, Ruminal total protein, ruminal chloride, Hb blood cell, MCV, MCHC, neutrophil %, Eosinophil %, basophil %, Lymphocyte %, serum total protein, albumin, calcium, Inorganic phosphorus, sodium, chloride and potassium. Inflammation of the soft palate group changes occur in ruminal ammonia nitrogen, ruminal total protein, ruminal urea, plasma RBCs, Hb, MCH, MCHC, neutrophil %, Eosinophil %, basophil %, serum total protein and albumin. While in frothy bloat group changes in ruminal pH, ruminal ammonia nitrogen, ruminal total protein, ruminal sodium, RBCs, Hb concentration, MCV, MCH, MCHC, neutrophil %, eosinophil %, basophil %, Lymphocyte %, calcium, Inorganic phosphorus, sodium, chloride and potassium. Also, contagious skin disease group changes in ruminal ammonia nitrogen, ruminal urea, ruminal chloride, RBCs, Hb concentration, MCH, MCHC, neutrophil %, eosinophil %, basophil %, monocyte % and serum calcium, inorganic phosphorus, sodium and chloride and potassium. But, mange group changes occur in ruminal ammonia nitrogen, ruminal total protein, ruminal urea, ruminal potassium, RBCs, Hb concentration, MCH, MCHC, neutrophil %, eosinophil % and basophil %.

Key words: Dromedary camel, haematology, biochemistry, ruminal fluids, trypanosomiasis, mange, pasteurolesis, contagious skin disease, inflammation of soft palate, frothy bloat, indigestion and ruminal acidosis

INTRODUCTION

Although camels are an important source of milk, meat and wool and are widely used in transportation and for other working purposes, their potential has not yet been fully exploited (El-Gayoum, 1986). Due to their physiological attributes, Camels are the most suitable species of domestic mammals to be used under extremely arid conditions (Baraka *et al.*, 2000; George, 1992; Wernery, 1992; Yagil, 1985). Beside the significant tolerance to water shortage in desert areas which constitute the majority of Egyptian land camel rearing might have the potential to become of pivotal economical importance (Ramet, 2001).

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The diseases of the African camel have not been very extensively researched in comparison with other domesticated species probably owing partly to the non-sedentary nature of the herds, constantly moving in search of grazing and water. It is only in a few places, where the animals are found in favorable environments, often alongside other species, that attempts have been made to study camel pathology (Mukasa, 1981). The changes in ruminal and blood constituents in diseased camels have not been comprehensively studied.

Trypanosomiasis

Among camels is sometimes also referred to as *surra*. It has received much attention, being extensively discussed or investigated by almost everyone involved in camel medicine. It is caused by *Trypanosoma evansi*, present in most areas where camels are found. Bremaud (1969) also lists *T. congolense* as a possible cause of the disease. The organism is transmitted by *Tabanus*, *Stomoxys*, *Lyperosaa* and *Haematobia* flies (Scott, 1973), which are prevalent around river banks and watering points in the arid zones. Tsetse flies, the main vectors of bovine trypanosomiasis, are not involved in the transmission of *T. evansi* to camels.

External Parasites

Camel mange is sometimes considered the most important disease of dromedaries after trypanosomiasis. The only mite that infects camels is *Sarcoptes scabiei* var. *cameli* (Richard, 1976). Mange is a highly contagious disease which can spread to herdsmen or others associated with infected animals. The mite may be transmitted directly by contact or indirectly through objects such as saddles, harnesses, utensils, bedding and even tree trunks. It tends to spread more quickly during cold weather, when animal coats usually grow long and the animals huddle together more often.

Bacterial Diseases

Pasteurella mntocida in camel was considered a hazardous disease that drastically affect the productivity of camels. The bacterium was reported to affect a wide range of animals species (Seleim *et al.*, 2003).

Skin Disease

Such areas become infected, ulcerate and may lead to skin necrosis. Raw areas of flesh may be seen on the back or hump after the loss of the top skin and a wide variety of pyogenic organisms were isolated from these necrotic areas. Fazil (1977) indicates that skin necrosis among camels may be associated with salt deficiency. Once established, the ulcers spread to surrounding areas and there is little spontaneous healing. Domenech *et al.* (1977) studied the various pyogenic skin conditions of the dromedary in Ethiopia. It is a typical infection of the lymph nodes, caused by *Corynebacterium pseudotuberculosis* and *Streptococcus* of the Lancefield type B group. A mixed infection may occur and sometimes the abscesses may be due to *Staphylococcus* or *C. pyogenes* organisms. It is a chronic infection which often affects the lymph nodes at the base of the neck and around the hump. The abscesses are usually closed, cold and painless.

Inflammation of the Soft Palate

The camel is capable of protruding its soft palate beyond the lips. This balloon-like structure may sometimes be traumatized by sharp objects or during fighting and infections may result. The throat of affected animals becomes swollen and the camel may be unable to swallow. Breathing becomes laboured and the neck may be extended. Palatal inflammations of the camel tend to be chronic and often ulcerative. Leese (1969) recommended that the best corrective measure is to amputate the inflamed portion of the palate at the level of the first grinders. Little haemorrhage is encountered and the animals show almost instantaneous relief.

Bloat

Bloat or gas tympany occurs in camels under similar circumstances as in cattle and is handled in a similar manner. However, when a trocar is used to relieve the gas, a finer type than the cattle trocar is recommended. It is often unnecessary to use a trocar, since drugs may be just as effective. Fazil (1977) shows that the use of 0.85-1.14 L of linseed oil or any of the commercial anti-bloat drugs is effective.

Digestive Disturbances Are Common in Hand Fed Camels

Even in well fed racing camels, digestive disturbances are common and range from indigestion to vitamin B1 (thiamine) deficiency. The imbalance between fibre and concentrated carbohydrate induces a chronic (and sometimes acute) ruminal acidosis, seriously reducing healthy rumen fermentation and the bacterial synthesis of essential nutrients such as thiamine (Fazil, 1977).

The objective of this study was to investigate some biochemical, hematological and clinical studies of selected ruminal and blood constituents in camels affected by various diseases and compare them with the corresponding data obtained from normal animals that could be employed in controlling and monitoring diseases in camels.

MATERIAL AND METHODS

Animals

The set under study included 71 camels suffering from many diseases, The diseases were diagnosed on the basis of history and results of clinical and laboratory examination. Samples were collected from farms in Aswan Governorate and El-Basatin slaughter premises. Samples were packed separately in sterile plastic bags, labeled and transferred to the laboratory in ice box for biochemical and hematological examination.

Trypanosomiasis (n = 5), Mange (n = 4), contagious skin disease (n = 5), Pasteurelosis (n = 10) clinically infected camels with respiratory infection, Inflammation of soft palate (n = 3), Frothy bloat (n = 4), Indigestion (n = 10) and Ruminal acidosis (n = 10) and normal camels (n = 20).

The diseases were diagnosed on the basis of history and results of clinical and laboratory examination of ruminal fluids.

Trypanosomiasis

Diagnosed on the basis of microscopical findings in stained blood smears.

Pasterulosis

Blood samples were cultured directly on blood agar plates containing 5% sheep blood and incubated at 37°C for 24 h, Nasal swab were cultured indirectly by inoculation of 5 mL of brain agar plates, suspected colonies were morphologically and biochemical identified.

Mange and contagious skin diseases on the basis of findings in skin lesions.

Ruminal Samples

Samples of ruminal fluid were collected using rubber stomach tube and a suitable mouth gag. Larger particles were removed by filtering through a sieve and the filtrate was divided into three portions. The 1st part (2 mL) was used for determination of ammonia nitrogen conc. According to Conway (1957) method The 2nd part (2 mL) for determination of the total volatile fatty acids conc. Using the method described by Eidie *et al.* (1967). The rest was centrifuged at 3000 rpm for 15 min. the supernatant was used for determination of: total protein, urea, calcium, inorganic phosphorus and chloride concentration.

Blood Samples

Blood samples were collected into heparinized test tube by jugular vein puncture for determination of hemoglobin concentration, erythrocyte count, total and differential leukocyte counts.

Another blood samples was collected into a plain test tube and centrifuged to separate blood serum for determination of total protein, urea nitrogen, creatinine, uric acid ALT, AST, ALP, calcium, inorganic phosphorus and chloride. All biochemical analysis were carried out using the test kits produced by Bio-merieux and the results were read at appropriate wavelength using the Pye-Unicum spectrophotometer. The concentration of sodium and potassium were determined by Flame photometry using the technique described by Willered *et al.* (1965).

Statistical Analysis

The results were presented as mean values±standard error for groups were analysed using T test according to Perrie and Watson (1999).

RESULTS

Results in (Table 1) indicate that pH of the ruminal fluid show significant decrease in the groups of bloat and ruminal acidosis but other groups not changed than control one.

While the concentration of ruminal ammonia nitrogen increased in groups of trypanosomiasis, mange, Pasteurellosis, contagious skin disease and inflammation of the soft palate but decreased in bloat, indigestion and ruminal acidosis than the control one.

The concentration of ruminal volatile fatty acids, increased significantly in the group of ruminal acidosis while other groups not changed.

Ruminal total protein, show a significant decreased in trypanosomiasis, pasteurellosis, mange, inflammation of soft palate, bloat and indigestion than control group.

Ruminal urea, show a significant increased in the groups of trypanosomiasis, pasteurellosis, mange, inflammation of soft palate and contagious skin disease but decreased in other groups than healthy group.

Table 2 illustrate an increase in ruminal calcium in the groups of trypanosomiasis, pasteurellosis and ruminal acidosis while other groups show a non significant alteration. Also, the concentration of inorganic phosphorus show a significant increase in groups trypanosomiasis and non significant change in other groups. The concentration of ruminal sodium show a significant increase in the ruminal acidosis and bloat but other groups had a non significant changes.

Table 1: Ruminal (pH-Ammonia-Total volatile fatty acid-Total protein-Urea) in Camels suffering from several diseases

Diseases	pH	Ammonia (mmol L ⁻¹)	T. volatile fatty acid (mEq L ⁻¹)	T. Protein (g L ⁻¹)	Urea (mmol L ⁻¹)
Protozoal disease					
Trypanosomiasis	6.82±0.60	3.50±0.29**	5.40±0.37	7.95±0.61***	1.72±0.13**
External parasites					
Mange	6.75±0.58	3.29±0.23**	5.63±0.43	8.45±0.70***	1.65±0.04**
Bacterial disease					
Pasteurellosis	6.72±0.53	3.21±0.20**	4.95±0.40	7.67±0.72***	1.52±0.09**
Contagious skin necrosis	6.90±0.61	3.19±0.18**	5.25±0.50	9.73±0.82	1.62±0.03**
Miscellaneous diseases					
Inflammation of the soft palate	6.68±0.50	3.22±0.30**	5.12±0.48	8.15±0.69***	1.36±0.06**
Frothy bloat	4.52±0.45***	1.80±0.17**	5.09±0.41	6.70±0.59***	0.32±0.02*
Indigestion	6.86±0.42	1.62±0.31**	5.15±0.45	7.35±0.63***	0.56±0.04*
Ruminal acidosis	4.38±0.52***	1.73±0.11**	7.90±0.65***	9.59±0.80	0.55±0.04*
Control (Healthy Camels)	6.95±0.55	2.70±0.21	5.50±0.42	9.80±0.87	0.95±0.06

Each value represents the means±standard errors, Significance compared to control: *p<0.05, **0.01, ***0.001

Table 2: Ruminal (Calcium-phosphorus-sodium-potassium-chloride) in camels suffering from several diseases

Diseases	Calcium	Phosphorus	Sodium	Potassium	Chloride
	(mmol L ⁻¹)				
Protozoal disease					
Trypanosomiasis	3.17±0.23***	2.75±0.21***	113.25±11.24	33.60±3.10**	47.32±3.91***
External parasites					
Mange	1.82±0.16	1.42±0.12	105.70±9.72	24.70±2.30	40.25±3.50**
Bacterial disease					
Pasteurellosis	2.62±0.21**	1.70±0.13	111.50±10.40	39.82±2.30***	40.13±2.92**
Contagious skin necrosis	1.53±0.12	1.52±0.12	105.25±9.80	25.90±2.20	42.21±3.70**
Miscellaneous diseases					
Inflammation of the soft palate	1.63±0.14	1.21±0.09	107.55±10.60	26.75±2.25	34.40±2.91
Frothy bloat	1.55±0.11	1.30±0.12	121.65±11.50***	24.28±2.10	38.24±3.11
Indigestion	1.92±0.16	1.42±0.13	103.25±8.82	25.80±2.21	40.42±3.61**
Ruminal acidosis	4.21±0.36***	1.27±0.10	127.92±10.80***	38.70±3.90***	34.30±3.20
Control (Healthy Camels)	1.78±0.16	1.35±0.12	108.38±9.75	27.50±2.30	35.25±2.51

Each value represents the means±standard errors, Significance compared to control: **p<0.01, ***0.001

Table 3: Cellular blood constituents (RBCs-Hb-PCV-MCV-MCH-MCHC) in Camels suffering from several diseases

Diseases	RBCs	Hb	PCV	MCV	MCH	MCHC
	(10 ¹² L ⁻¹)	(g L ⁻¹)	(L L ⁻¹)	(fl)	(pg)	(%)
Protozoal disease						
Trypanosomiasis	13.45±1.25***	138.20±9.24	23.15±2.20***	13.95±1.15***	11.40±1.20	62.50±6.45
External parasites						
Mange	13.95±1.20***	120.10±10.90**	25.68±2.15***	20.15±1.82	8.12±0.61***	40.15±3.20***
Bacterial disease						
Pasteurellosis	14.10±1.15***	139.20±1.20	24.50±2.10***	14.01±1.22***	12.09±1.23	61.70±5.95
Contagious skin necrosis	14.95±1.35***	125.50±10.90**	28.75±2.05	20.15±1.95	7.90±0.62***	45.15±3.20***
Miscellaneous diseases						
Inflammation of the soft palate	14.50±1.62***	127.20±11.30**	29.35±2.80	19.35±1.82	8.30±0.70***	43.25±4.15***
Frothy bloat	14.15±1.30***	142.50±10.50**	28.65±2.60	23.15±2.41**	17.65±1.91***	80.63±7.21***
Indigestion	12.50±1.20	196.20±19.50***	28.70±2.90	16.70±1.53***		12.45±1.21***
Ruminal acidosis	14.61±1.51***	170.72±14.50***	28.72±2.52	24.12±2.71**	14.25±1.52**	57.50±5.80
Control (Healthy Camels)	18.10±1.21	136.50±12.50	32.70±2.91	20.65±1.75	12.45±1.21	64.65±5.92

Each value represents the means±standard errors, Significance compared to control: **p<0.01, ***0.001

In case of Potassium, there is a significant increase in ruminal acidosis, pasturellosis and trypanosomiasis. Chloride, show a significant increase in case of indigestion, contagious skin disease, pasturellosis, mange and trypanosomiasis.

As regard to the blood cell (Table 3) a significant decrease in the RBCs in all groups except in indigestion group and there is a significant increase in the level of Hb concentration in case of bloat, indigestion, ruminal acidosis than control groups while significant decrease in case of mange, contagious skin disease and inflammation of palate. There is a significant decrease of PCV in trypanosomiasis, mange and pasturellosis. On the same time, MCV show a significant decrease in trypanosomiasis, pasturellosis and indigestion but significant increase in bloat and ruminal acidosis. In case of MCH, a significant decrease in case of mange, contagious skin disease and inflammation of palat while a significant increase in ruminal acidosis and bloat. MCHC show a significant increase in bloat and indigestion but a significant increase in inflammation of palate, contagious skin disease and mange.

Table 4 show a non significant change in total white blood corpuscle in all diseased groups than control group. But neutrophil % show a significant decrease in mange, contagious skin disease, inflammation of palate, bloat, indigestion but increase in case of ruminal acidosis than control one. Eosinophil % and basophil % were significantly decreased in all groups than control one but monocyte % show a significant increase in mange and contagious skin disease. Lymphocyte % significantly increased in trypanosomiasis, pasterullosis and indigestion but decrease in bloat.

Biochemical analysis of serum samples (Table 5) revealed a decrease in total protein and albumin concentration in the groups trypanosomiasis, pasturellosis, inflammation of palate, indigestion and ruminal acidosis while the reminder groups non significant change than control.

Table 4: Cellular blood constituents (WBCs-Neutrophil-Eosinophil-Basophil-Monocytes- Lymphocytes) in Camels suffering from several diseases

Diseases	WBCs (10 ⁹ L ⁻¹)	Neutrophil	Eosinophil	Basophil	Monocytes	Lymphocytes
Protozoal disease						
Trypanosomiasis	6.15±0.60	32.09±3.50	1.92±0.15	1.26±0.24	56.56±5.45	8.15±0.91***
External parasites						
Mange	5.35±0.45	27.10±2.15**	1.10±0.09	1.03±0.05	65.50±5.03**	5.20±0.91
Bacterial disease						
Pasteurellosis	5.95±0.59	31.50±3.70	1.85±0.25	1.30±0.35	57.25±5.50	8.34±0.92***
Contagious skin necrosis	5.90±0.82	27.15±2.50**	0.80±0.05	1.03±0.04	63.70±5.20**	5.35±0.42
Miscellaneous diseases						
Inflammation of the soft palate	5.50±0.61	26.35±3.21**	0.75±0.06	1.12±0.08	57.43±4.35	5.60±0.52
Frothy bloat	6.25±0.70	27.15±3.10**	1.00±0.01	0.85±0.07	68.02±4.21**	5.12±0.32
Indigestion	6.10±0.70	27.65±2.50**	2.25±0.45	1.42±0.12	56.60±5.21	7.17±0.52***
Ruminal acidosis	6.15±0.62	41.25±4.21***	1.15±0.71	0.95±0.04	57.25±4.21	5.52±0.60
Control (Healthy Camels)	5.75±0.55	32.26±3.15	2.25±0.30	2.15±0.13	58.20±4.91	5.43±0.50

Each value represents the means±standard errors, Significance compared to control: **p<0.01, ***p<0.001

Table 5: Biochemical blood constituents (Total protein-albumin-globulin –A/G ratio) in Camels suffering from several diseases

Diseases	T.Protein	Albumin (g dL ⁻¹)	Globulin	A/G
Protozoal disease				
Trypanosomiasis	5.30±0.72***	1.05±0.35***	4.25±0.36	0.63
External parasites				
Mange	6.80±0.53	2.10±0.29	4.70±0.27	0.45
Bacterial disease				
Pasteurellosis	5.00±0.63***	1.12±0.31***	3.88±0.42	0.74
Contagious skin necrosis	7.05±0.65	2.26±0.33	4.79±0.35	0.47
Miscellaneous diseases				
Inflammation of the soft palate	5.90±0.71***	1.15±0.30***	4.75±0.46	0.45
Frothy bloat	7.85±0.55	2.15±0.25	5.70±0.45	0.38
Indigestion	6.15±0.75	2.05±0.35	4.10±0.47	0.50
Ruminal acidosis	5.85±0.45***	1.05±0.28***	4.80±0.35	0.54
Control (Healthy Camels)	7.80±0.65	3.18±0.32	4.62±0.52	0.39

Each value represents the means±standard errors, Significance compared to control: ***p<0.001

Table 6: Biochemical blood constituents (Blood urea nitrogen-Creatinine-Uric acid-ALT-AST) in Camels suffering from several diseases

Diseases	BUN mmol L ⁻¹	Creatinine mg dL ⁻¹	Uric acid mg dL ⁻¹	ALT U L ⁻¹	AST U L ⁻¹
Protozoal disease					
Trypanosomiasis	4.70±0.42***	1.90±0.08***	2.50±0.17***	26.35±3.15***	43.50±4.21***
External parasites					
Mange	2.09±0.29	1.01±0.40	1.72±0.12	20.15±2.15	35.25±3.21
Bacterial disease					
Pasteurellosis	4.65±0.38***	1.95±0.05***	2.61±0.21***	25.50±2.65***	40.35±3.90***
Contagious skin necrosis	2.21±0.30	0.93±0.07	1.68±0.15	20.50±2.32	34.75±3.22
Miscellaneous diseases					
Inflammation of the soft palate	4.50±0.41***	1.96±0.08***	2.55±0.20***	27.65±2.71***	42.20±3.85***
Frothy bloat	2.55±0.30	1.02±0.32	1.61±0.13	19.69±2.13	35.25±3.21
Indigestion	2.95±0.25	0.99±0.09	1.56±0.15	20.34±2.15	34.75±2.92
Ruminal acidosis	4.10±0.40***	1.93±0.40***	2.21±0.14***	20.25±2.14	31.45±4.12
Control (Healthy Camels)	2.15±0.33	0.85±0.05	1.68±0.13	19.75±2.11	34.50±2.95

Each value represents the means±standard errors, Significance compared to control: ***p<0.001

Regarding to the kidney function parameters the results in (Table 6) indicate severe kidney affection which was manifested by a significant increase of urea, creatinine and uric acid in case of trypanosomiasis, pasteurellosis, inflammation of palate and ruminal acidosis while liver function parameters show an elevation in ALT and AST in trypanosomiasis, pasteurellosis and inflammation of palate groups.

Table 7: Biochemical blood constituents (Calcium-Phosphorus-Sodium-Potassium-Chloride) in Camels suffering from several diseases

Diseases	Calcium	Phosphorus	Sodium (mmol L ⁻¹)	Potassium	Chloride
Protozoal disease					
Trypanosomiasis	1.35±0.13***	1.49±0.25**	132.25±13.50**	6.15±0.39***	41.30±8.75***
External parasites					
Mange	2.69±0.22	2.40±0.22	171.15±15.52	4.42±0.51	69.90±7.70
Bacterial disease					
Pasteurellosis	1.20±0.11***	1.06±0.21***	141.33±13.70**	6.25±0.40***	47.30±7.25***
Contagious skin necrosis	1.10±0.21***	1.43±0.20**	140.20±12.20**	6.49±0.53***	41.24±8.50***
Miscellaneous diseases					
Inflammation of the soft palate	2.65±0.20	2.50±0.23	149.20±14.25	4.21±0.39	60.20±7.35
Frothy bloat	1.26±0.13***	1.60±0.30***	120.25±12.30**	6.75±0.25***	42.50±8.21***
Indigestion	1.21±0.23***	1.58±0.29**	128.25±14.35**	6.50±0.51***	35.30±7.21***
Ruminal acidosis	2.63±0.21	2.35±0.25	140.15±12.70	6.35±0.43	60.21±8.33
Control (Healthy Camels)	2.90±0.10	2.48±0.26	160.07±13.20	4.58±0.53	65.67±6.23

Each value represents the means±standard errors, Significance compared to control: **p<0.01, ***0.001

Table 7 indicate a significant decrease in the levels of calcium, Inorganic phosphorus, sodium and chloride while potassium was significantly increased than control one in trypanosomiasis, pasteurellosis, bloat, indigestion and contagious skin disease groups.

DISCUSSION

Ruminal Parameters

Ruminal pH

A significant decrease in the groups of bloat and ruminal acidosis (Table 1) can be explained as a result of ruminal atony affecting the rate of fermentation and/or hydrolysis and thereby the production of acid or alkaline intermediates (Baraka *et al.*, 2000; Bradford, 1990).

Ruminal Ammonia Nitrogen

The controversial changes in concentration of ruminal ammonia nitrogen, increased in groups of trypanosomiasis, mange, Pasteurolesis, contagious skin disease and inflammation of the soft palate but decreased in bloat, indigestion and ruminal acidosis than the control one (Table 1) can be attributed to the fact that the feeding time was unknown (Kubesy, 1987) but (Hristov and Ropp, 2003) indicate that if energy is limiting in the rumen, microorganisms degrade feed protein to ammonia and ammonia uptake by ruminal microorganisms is inhibited. While Kamel and Al-Dobaib (2007) and Feng *et al.* (1993) reported significant reduction in ammonia concentration in the rumen as the diet contained increasing levels of fiber with a moderate rate of fermentation. A decrease of the ruminal ammonia nitrogen concentration associated with simple indigestion or ruminal acidosis and a decrease associated with frothy bloat was also observed by Kubesy (1987) in sheep.

Ruminal Volatile Fatty Acids

Ruminal volatile fatty acids, increased significantly in the group of ruminal acidosis (Table 1) and this elevation of VFAs can be used as a relative measurement in feed evaluation taking into account that there is no VFAs absorption in the rumen because the ruminal liquid reflects the microbial activity and the absorptions rate through the ruminal wall (Owens *et al.*, 1997). While Shahera *et al.* (2007) and Shahin *et al.* (2006) show that high energy supplemented diets increased the concentration of total VFA compared with the low energy intake diets.

Ruminal Total Protein

Considerable fluctuations in the ruminal total protein concentration, decreased in trypanosomiasis, pasteurellosis, mange, inflammation of soft palate, bloat and indigestion (Table 1)

can be explained in terms of findings of Kholif and Khrshed (2006), who reported direct proportionality between the content of protein in the ration and the concentration of total ruminal proteins.

Ruminal Urea

The ruminal urea concentration (Table 1), increased in the trypanosomiasis, pasteurellosis, mange, inflammation of soft palate and contagious skin disease but decreased in other groups depends on the rate of production and absorption of ammonia nitrogen (Bartley *et al.*, 1976) as well as on the rate of detoxification of ammonia into urea in the liver (Baraka *et al.*, 2000; Visek, 1972).

Ruminal Calcium, Inorganic Phosphorus, Sodium, Potassium and Chloride

Increase in ruminal calcium, inorganic phosphorus, sodium, potassium and chloride (Table 2) in some diseases. Revealed that ruminal minerals availability is a key prerequisite for the formation of insoluble complexes that may or may not become solubilized for absorption at the appropriate sites. And the possible explanation of these interrupted values of ruminal macro-elements and electrolytes is that the changes of sodium and potassium levels were attributed to the levels of them in the saliva and in the ration (Baraka *et al.*, 2000).

Plasma Blood Cells

As regards to results of the blood cells (Table 3, 4), the possible explanation of these controversial results of cellular blood constituents and indexes could be attribute to the discrepancy in RBCs count and size, Hb content and PCV% and consequently the erythrocytic indexes with a concomitant status of dehydration or rehydration as reported by Baraka *et al.* (2000) and Yagil *et al.* (1974). Similar results for dromedary camels affected by trypanosomiasis were published by (Karram *et al.*, 1991). On the other hand, Manaa (1990) and Abd El-Samee (1987) reported for such camels an increase in relative counts of eosinophils, lymphocytes and monocytes and a decrease in relative counts of neutrophils and basophils. Also, Schalm *et al.* (1986) revealed that, there is a significant increased in erythrocytes in stressed camels which may be attributed to the change of composition and concentration of plasma proteins in response to the stress conditions. While Nielsen (1984) observe that there is a slight elevation in RBCs, PCV and Hb content in stressed camels may be reflect the ability of camels to conserve water mainly by reducing urinary and faecal excretion. Concerning leuogram (Gwazdauskas *et al.*, 1980; ParaPe *et al.*, 1973) show that leucocytosis, neutrophilia and lymphocytopenia in camels may be attributed to release of endogenous corticosteroids in response to stress which have a major role in regulating circulating concentration of leucocytes.

Serum Biochemical Parameters

Table 5 illustrate the levels of total protein, albumin and globulin and this decrease was explained as in response to the parasitic antigen in case of trypanosomiasis and pasterollosis (Moustafa *et al.*, 1991) or may be due to the stresses which cause a decrease in total serum protein, decrease in albumin and increase in globulin, this increase may be due to the stimulation of the immune system and induction of immunoglobulins against any infection (Singh and Jayprakashan, 2001; Brenman *et al.*, 1998; Koneka *et al.*, 1997).

Regarding to the kidney function parameters (Table 6) the results indicate severe kidney affection which was manifested by the significant increase of the urea, creatinine and uric acid in trypanosomiasis, pasteurellosis, inflammation of palate and ruminal acidosis, this result attributed to the acidosis or could be attributed to renal primarily insufficiency caused by decreased renal blood flow (Seleim *et al.*, 2003).

Serum ALT and AST (Table 6) show an elevation in trypanosomiasis, pasteurellosis and inflammation of palate (Seleim *et al.*, 2003) recorded that an elevation of these enzymes may be due to hepatic toxicosis.

Decreased serum Calcium levels (Table 7) in case of trypanosomiasis, pasturellosis, Bloat, indigestion and contagious skin disease can be attributed to a decrease in both intake and absorption of calcium due to anorexia or gastrointestinal atony usually associated with primary indigestion and other diseases (Blood and Radostitis, 1989; Parsad, 1977), or due to the hypoproteinemia as the serum calcium existed in protein-bound form that could not be replenished by reabsorption due to renal cells damage (Hoskins *et al.*, 1997; Mullan and Lax, 1996).

Sodium and chloride (Table 7) were decreased while potassium was significantly increased due to disturbance in the acid / base balance incurred by the septicemia (Seleim *et al.*, 2003; Koneka *et al.*, 1997; Tietz, 1994).

Thus, insignificant changes of electrolyte concentrations in camels suffering from simple indigestion were reported by Abd El-All *et al* (1986), Abd El-Samee (1987) and Manaa (1990) found insignificant changes in camels affected by trypanosomiasis. It has been well established that serum electrolyte concentrations are influenced by the amount of secreted saliva, the rate of sodium and potassium secretion and / or sequestration in the abomasums and the rate of renal excretion and absorption as affected by acid-base imbalance (Blood and Radostitis, 1989; Melvin, 1970). This may explain the unusual behaviour of the individual electrolyte concentrations.

CONCLUSIONS

Previous results and published data indicate that more detailed investigations of ruminal and blood constituents in diseased camels are needed.

Our investigations showed significant changes in camel suffering from:

- Ruminal acidosis : There is changes in ruminal pH, ammonia nitrogen, VFA, ruminal calcium, sodium, potassium and in RBCs, Hb, MCV, MCH and neutrophil % Eosinophil %, basophil %, in blood cell, Also, changes in serum total protein, albumin, urea, creatinine and uric acid.
- Trypanosomiasis, Pasteurolesis : Changes in ruminal ammonia nitrogen, ruminal total protein, ruminal urea, ruminal calcium, potassium, inorganic phosphorus (only in trypanosomiasis) and ruminal Chloride, Eosinophil %, basophil % in blood cell and serum total protein and albumin.
- Indigestion : Changes in ruminal ammonia nitrogen, Ruminal total protein, ruminal Chloride, Hb blood cell, MCV, MCHC, neutrophil %, Eosinophil % and basophil %, Lymphocyte %, serum total protein and albumin, calcium, Inorganic phosphorus, sodium, chloride and potassium.
- Inflammation of the soft palate : Ruminal ammonia nitrogen, ruminal total protein, ruminal urea, plasma RBCs, Hb, MCH, MCHC, neutrophil %, Eosinophil % and basophil %, serum total protein and albumin.
- Frothy bloat : Ruminal pH, ruminal ammonia nitrogen, ruminal total protein, ruminal sodium, RBCs, Hb concentration, MCV, MCH, MCHC, neutrophil %, eosinophil %, basophil %, Lymphocyte %, calcium, Inorganic phosphorus, sodium and chloride and potassium.

- Contagious skin disease : Ruminal ammonia nitrogen, ruminal urea, ruminal chloride, RBCs, Hb concentration, MCH, MCHC, neutrophil %, eosinophil %, basophil %, monocyte % and serum calcium, inorganic phosphorus, sodium and chloride and potassium
- Mange : Ruminal ammonia nitrogen, ruminal total protein, ruminal urea, ruminal potassium, RBCs, Hb concentration, MCH, MCHC, neutrophil %, eosinophil %, basophil %.

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