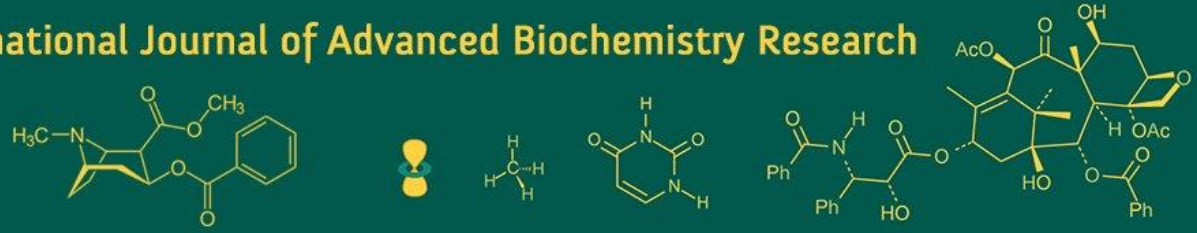
International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(1): 337-341
www.biochemjournal.com
Received: 14-10-2023
Accepted: 29-11-2023

MK Dhaka
Department of Veterinary Clinical Medicine, Ethics and Jurisprudence, CVAS, Bikaner, Rajasthan, India

Sunita Choudhary
Department of Veterinary Clinical Medicine, Ethics and Jurisprudence, CVAS, Bikaner, Rajasthan, India

FC Tuteja
ICAR-National Research Centre on Camel, Jorbeer, Shagbark, Bikaner, Rajasthan, India

AP Singh
Department of Veterinary Clinical Medicine, Ethics and Jurisprudence, CVAS, Bikaner, Rajasthan, India

Kavita Jaidiya
Department of Veterinary Clinical Medicine, Ethics and Jurisprudence, CVAS, Bikaner, Rajasthan, India

V Punia
Department of Veterinary Parasitology, CoVS & A.H., Jabalpur, Madhya Pradesh, India

Corresponding Author:
MK Dhaka
Department of Veterinary Clinical Medicine, Ethics and Jurisprudence, CVAS, Bikaner, Rajasthan, India

Study on changes in Haemato-biochemical parameters of pica affected camels with Mineral mixture and salt supplementation

MK Dhaka, Sunita Choudhary, FC Tuteja, AP Singh, Kavita Jaidiya and V Punia

DOI: https://doi.org/10.33545/26174693.2024.v8.i1e.374

Abstract
The present study was carried out to measure haematological and biochemical parameters changes in pica affected camels and its changes after supplementation of mineral mixture with salt in these camels. The proposed study was carried out in an organized camel herd at NRCC, Bikaner. The 18 severely pica affected camel were selected for study on the basis of clinical signs and divided into 3 groups, group A treated with mineral mixture and group B was given mineral mixture with common salt and one untreated control group (group C) to evaluate haematological and biochemical changes in different groups. Blood samples were collected every 15 days of interval up to 60 days for hematological and biochemical evaluation. The mean values of total erythrocyte count, haemoglobin, PCV, Neutrophils, total protein and globulin, that was initially low tend to increase in both treatment groups whereas lymphocyte count was decreased and were significantly similar to healthy control at 60th days in both treatment groups but remained significantly different in untreated group. However, salt treated group B has shown better improvement in haemato-biochemical values over Group A which was only on mineral mixure. The present study showed additional salt supplementation along with mineral mixture gives better results in cases of pica in terms of hamematological and biochemical parameters.

Keywords: Pica in camel, mineral mixture, common salt, haematological and biochemical parameters

Introduction
Camel is the most suitable mammal for use in extreme climatic conditions (Wilson, 1984; Yagil, 1985) [25, 26]. Camel farming is mainly both the organised (tola keepers) and unorganised (one to few animal keepers). Farmers do not follow any scientific feeding plan and only the available feeds are being offered to the camels.
Pica has potential side effects that most commonly affect the intestine and bowel. Complications can include constipation, cramping, pain, obstruction, perforation from sharp objects like rocks or gravel, contamination, and infection from soil-dwelling parasites (Firyal, 2007) [7].
Complete mechanism of pica has not been understood yet; it has been known to be associated with parasitism and deficiencies of phosphorus, salt and protein (Smith, 2015) [22]. Minerals like copper, zinc, and cobalt, has been implicated in the aetiology of pica and fleece dietary pattern in sheep (Fahmy *et al*., 1980) [6].
Hence, the present study has been undertaken to study the haemabiochemical changes in pica affected camels and efficacy of mineral mixture with salt supplementation compared to feeding of only mineral mixture in haematological and biochemical parameters.

Materials and Methods
In the Feeding trial experiment, 18 male camels were selected based on clinical sign and symptoms during observation and these were divided into three groups comprising six animals in each group. In this trial six animals of group-A were fed with specially designed mineral mixture daily at the rate of 30 gram per animal per day mixed with fodder for two month, six animals of group-B were fed mineral mixture 30 gram + 20 gram common salt per animal per day mixed with fodder for two month, whereas six animals of group-C were fed with same basal fodder for two months. In group-D healthy control animal were taken which were not showing any signs of pica.

To know the intensity of parasitic infections in camels, collected faecal samples were processed and examined as qualitative examination was conducted to record the gastrointestinal parasitic infections in camel population on the basis of presence/absence of eggs/cysts/oocysts in the faeces by using centrifugal floatation and sedimentation techniques (Soulsby, 1982) [24]. Two grams of strained faecal sample was mixed with ordinary water in 15 ml centrifuge tube and centrifuged for 1-2 min at 1500 RPM. The supernatant was removed and similarly two washings were given so that the colour of the faecal sample was removed. After last washing, the faecal decant at the bottom of the tube was mixed with Sheather's sugar solution and was filled up to its brim and was covered with clean coverslip. After few minutes the coverslip was then picked up gently and put over a slide for examination under low power objective (10X).

For haematobiochemical examination blood samples from these 18 camels were collected from jugular vein puncture in sterile vacuutainers having ethylene diamine tetra acetic acid (EDTA) disodium salt as an anticoagulant added at the rate of 1mg/ml of blood of as recommended by Jain (1986) [10]. And simultaneously collected in another sterile vacuutainers having no anticoagulant. These vacuutainers tubes were kept in slanting position for one hour at 37 °C. Blood clots of these slants were broken and tubes were centrifuged at 3000 rpm for 15 min. The serum was harvested in small Pyrex tubes and was stored in the deep freeze at -20 °C till analysis.

For haematological examination blood samples were analysed for haemoglobin, packed cell volume, total erythrocyte count, total leukocyte count and differential leukocyte count as described by Jain (1986) [10].

Biochemical analysis of serum samples was made to ascertain liver function by estimating serum total protein, albumin and globulin, alkaline phosphatase (ALKP), serum aspartate aminotransferase (SGOT) and serum alanine aminotransferase (SGPT). These were determined by the colorimetric method with kits supplied by AGD Biomedicals Private limited using Smart-Spec Plus Spectrophotometer (Bio Rad).

Results and Discussion

Faecal examination

Faecal examination of the 21 pica affected camels revealed that none of the camel was affected with heavy parasitic load. Since no heavy parasitic infestation was recorded, therefore no special deworming was under taken. Such minor recurring infestations are being taken care by the regular deworming schedule being followed at four-month interval with changing dewormers.

Haematological parameters

Table 1: Comparative mean ± SE values of haematological parameters of healthy control group D with group A, group B and group C on day0 and day 60

Parameters	Healthy animal (Group-D)	Treated group (Group-A)		Treated group (Group-B)		Untreated group (Group-C)	
		0th day	60th day	0th day	60th day	0th day	60th day
RBCs (10^6/ mm^3)	10.99^{C}±0.44	6.87^{D}±0.21	10.94^{C}±0.60	6.86^{D} ±0.21	12.07^{C}±0.59	6.98^{D}±0.14	8.23^{D}±0.73
Hb (gm percent)	11.42^{C}±0.51	7.58^{D}±0.35	9.00^{D}±0.29	8.17^{D}±0.33	10.67^{C}±0.42	7.83^{D}±0.51	7.58^{D}±0.44
PCV (percent)	31.17^{C}±1.63	21.01^{D}±0.97	24.93^{D}±0.80	22.62^{D}±0.92	29.55^{C}±1.17	21.70^{D}±1.41	21.01^{D}±1.21
Leukogram							
TLC (10^3/mm^3)	16.41±1.43	18.27 ±3.92	22.82 ±3.08	19.92 ±3.93	18.25 ±1.41	20.04±2.33	19.90±4.06
Lymphocyte	33.17^{C}±1.92	53.67^{D} ±3.50	41.33^{D} ±2.33	50^{D} ±1.83	32^{C}±1.57	52.50^{D}±5.35	53.17^{D}±1.52
Neutrophils	60.50^{C}±2.49	40.17^{D} ±3.58	52.33^{D} ±2.20	43.50^{D} ±1.48	60.50^{C}±1.91	41.00^{D}±5.43	38.17^{D}±1.58
Eosinophils	1.67±0.33	2.17 ±0.31	2.50 ±0.34	2.17 ±1.01	3.17 ±0.79	2.17±0.83	3.50±0.92
Basophils	0.4 ±0.24	0.50 ±0.22	0.17 ±0.17	0.33 ±0.21	0	0	0.50±0.22
Monocytes	3.00 ±0.37	3.50 ±0.56	3.67 ±0.67	4.00 ±0.58	4.33 ±0.49	4.17±0.83	4.67±0.42

Note: Mean ±SE bearing different superscript (C, D) between treated and healthy control camels differ significantly (p<0.05).

In the feeding trial experiment, significantly low in the mean value of total erythrocyte count, haemoglobin, PCV and neutrophils were recorded in the treated groups A and B and untreated group C on day 0 (p<0.05) compared to healthy control group D. Whereas significant decrease in the mean value of haemoglobin, PCV and neutrophils were also recorded in the treated group-A and C on day 60 (p<0.05) post-treatment compared to healthy control group D.

In accordance with other researchers (Singh *et al*., 1986; Singh, 1993 and Beniwal and Singh, 2007) [19, 20, 4]. Decrease in total erythrocyte count found in present study in pica affected camels is conformity with (Singh *et al*. 1986; Singh, 1993; Beniwal and Singh, 2007; Koted, 2019) [19, 20, 4, 11]. Decrease in PCV in pica affected camels were reported by Singh *et al*., 1986; Singh, 1993 and Beniwal and Singh, 2007 [19, 20, 4]. High post treatment values of more than 50 percent recorded in the present study is in agreement with various workers for neutrophils counts of more than 50 percent in healthy camels (Singh *et al*., 2000; Gorakhmal *et al*., 2001 and Mali, 2002) [21, 9, 12].

In group B, post treatment values of total erythrocyte count, haemoglobin, PCV and neutrophils were significantly similar to healthy control group D. Significant increase in the mean value of lymphocyte count were recorded in the both treated groups A and B and untreated group C on day 0 (p<0.05) pre-treatment compared to healthy control group D. Comparative similar Hb values in the range of 8-12 gm/dl in healthy camels have been reported by other authors (Singh *et al*., 2000; Gorakhmal *et al*., 2001 and Mali, 2002) [21, 9, 12]. A comparative similar erythrocyte count in the range of 7- 11x106 cell/µl has been reported in healthy camels (Al-Ali *et al*., 1988; Alhadrami, 1997; Salahledin *et al*. 1979; Rezakhani *et al*. 1997; Dongre, 2000; Singh *et al*., 2000 and Mali, 2002) [1, 2, 17, 16, 5, 21, 12]. Comparative similar PCV values (25-30%) in healthy camels were recorded by Rezakhani *et al*. (1997) [16], Sharma (2000) [18] and Mali (2002) [12]. Whereas PCV values of more than 40 percent in healthy camels were reported by Soliman and Shaker (1967) [23]. Almost similar TLC values for healthy camels were recorded by Nassar *et al*. (1977) [14] Ghodrian *et al*. (1978) [8] Al-Ali *et al*. (1988) [1] Alhadrami (1997) [2]. Low TLC values

in healthy camels were recorded by Dongre (2000) [5], Sharma (2000) [18] and Mali (2002) [12].

Whereas significant increase in the mean value of lymphocyte count were also recorded in the treated group-A and C on day 60 (p<0.05) post-treatment compared to healthy control group D. In group B, post treatment values of lymphocyte count were significantly similar to healthy control group D. High lymphocytic values (>55%) in healthy camels were recorded by Soliman and Shaker (1967) [23] and Dongre (2000) [5].

Table 2: Comparative mean ±SE values of haematological parameters in Group A, Group B and Group C at different intervals of treatment

Parameter	Treated group (Group-A)					Treated group (Group-B)					Untreated group (Group-C)				
	0th day	15th day	30th day	45th day	60th day	0th day	15th day	30th day	45th day	60th day	0thday	15th day	30th day	45th day	60th day
Erythrogram															
RBCs (10^6/mm^3)	6.87^{a}± 0.21	7.99^{aA} ±0.48	8.46^{aA} ±0.38	9.90^{bB}± 0.41	10.94^{bB} ±0.60	6.86^{a}± 0.21	8.07^{aA}± 0.66	10.63^{bB} ±0.71	11.86^{bB} ±0.50	12.07^{bB} ±0.59	6.98±0 .14	7.28^{A}± 0.51	7.79^{A}± 0.33	8.36^{A}± 0.64	8.23^{A}± 0.73
Range	6.11-7.35	6.65-9.60	7.40-9.68	8.37-11.08	8.97-12.75	6.12-7.49	6.15-10.95	8.64-12.60	10.23-13.56	9.40-13.65	6.55-7.56	5.62-8.91	6.71-9.15	6.18-10.14	5.32-10.28
Hb (gm percent)	7.58^{a}± 0.35	8.17^{aA} ±0.36	8.08^{aA}± 0.35	8.33^{aA}± 0.28	9.00^{bB} ±0.29	8.17^{a}± 0.33	8.58^{aA}± 0.40	8.83^{aA}± 0.38	10.17^{bB} ±0.48	10.67^{bB} ±0.42	7.83±0 .51	8.33^{A}± 0.46	8.00^{A}± 0.53	7.58^{A}± 0.44	7.58^{A}± 0.44
Range	6.5-9.0	7.0-9.5	7.0-9.0	7.5-9.0	8.0-10.0	7.0-9.0	7.5-10.0	7.5-10.0	8.5-11.5	9.5-12.0	6.0-9.5	6.5-9.5	6.0-9.5	6.0-9.0	6.0-8.5
PCV (percent)	21.01^{a} ±0.97	22.63^{a} ^{A}±0.99	22.39^{aA} ±0.97	23.09^{aA} ±0.77	24.93^{bA} ±0.80	22.62^{a} ±0.92	23.78^{aA} ±1.10	24.47^{aA} ±1.05	28.17^{bB} ±1.32	29.55^{bB} ±1.17	21.70± 1.41	23.09^{A} ±1.27	22.16^{A} ±1.48	21.01^{A} ±1.21	21.01^{A} ±1.21
Range	18-25	19-26	19-25	21-25	22-28	19-25	21-28	21-28	24-32	26-33	17-26	18-26	17-26	17-25	17-24
Leukogram															
TLC (10^3/mm^3)	18.27± 3.92	16.82± 1.69	19.37±4 .13	21.12±3 .01	22.82±3 .08	19.92± 3.93	16.63±2 .34	15.72±2 .30	17.40±1 .85	18.25±1 .41	20.04± 2.33	17.86± 2.60	18.82± 3.56	20.52± 3.91	19.90± 4.06
Range	10.60-36.15	11.20-22.60	10.90-38.70	12.90-34.20	14.30-33.40	9.96-33.15	9.60-24.10	8.80-23.10	11.20-22.40	14.70-23.70	13.60-27.05	11.25-28.45	10.70-33.50	13.80-37.70	10.60-35.80
Lymphocyte (%)	53.67^{a} ±3.50	47.17^{a} ^{A} ±4.75	44.33^{aA} ±2.88	40.17^{bB} ±1.25	41.33^{bB} ±2.33	50^{a}±1. 83	44.50^{aB} ±3.83	42.50^{aA} ±2.50	35.83^{bB} ±1.33	32^{bB}±1. 57	52.50± 5.35	56.17^{A} ±6.03	51^{A}±2. 07	51.33^{A} ±1.61	53.17^{A} ±1.52
Range	41-63	30-64	38-54	37-44	34-48	45-56	33-54	34-52	32-41	27-36	31-70	32-73	43-58	47-57	49-59
Neutrophils (%)	40.17^{a} ±3.58	43.67^{a} ^{A}±4.51	47.83^{aA} ±2.52	51.67^{bB} ±1.09	52.33^{bB} ±2.20	43.50^{a} ±1.48	47.50^{aA} ±3.97	49.50^{aB} ±2.49	56.83^{bB} ±1.22	60.50^{bB} ±1.91	41.00± 5.43	38.00^{A} ±5.24	41.17^{A} ±2.81	39.83^{A} ±2.32	38.17^{A} ±1.58
Range	32-54	32-61	40-56	49-56	47-59	37-48	37-60	41-58	53-61	55-67	23-62	23-58	33-52	31-47	32-43
Eosinophils (%)	2.17±0 .31	3.83±0 .87	4.50±0. 62	4.00±0. 45	2.50±0. 34	2.17±1. 01	2.33±0. 56	3.83±0. 65	3.17±0. 31	3.17±0. 79	2.17±0 .83	2.00±0. 73	3.67±0. 80	3.50±0. 43	3.50±0. 92
Range	1-3	2-8	3-7	3-6	1-3	0-7	1-5	2-6	2-4	1-6	1-6	0-5	1-6	2-5	1-6
Basophils (%)	0.50±0 .22	0.33±0 .21	0.17±0. 17	0	0.17±0. 17	0.33±0. 21	0.33±0. 21	0.17±0. 17	0	0	0	0	0.33±0. 21	0.50±0. 22	0.50±0. 22
Range	0-1	0-1	0-1	0	0-1	0-1	0-1	0-1	0	0	0	0	0-1	0-1	0-1
Monocytes (%)	3.50±0 .56	5.00±0 .63	3.17±0. 79	4.17±0. 65	3.67±0. 67	4.00±0. 58	5.33±0. 49	4.00±0. 58	4.17±0. 70	4.33±0. 49	4.17±0 .83	3.83±0. 70	3.83±0. 83	4.67±0. 88	4.67±0. 42
Range	2-6	2-6	1-6	2-6	2-6	2-6	3-6	2-6	1-6	3-6	2-6	2-7	1-6	1-7	3-6

Note: 1. Mean ±SE bearing different superscript (A, B) between treated and control group differ significantly (p<0.05)
2. Mean ±SE bearing different superscript (a, b) within treated group differ significantly (p<0.05)

In the feeding trial experiment, significant increase in the mean value of total erythrocyte count, haemoglobin, packed cell volume and neutrophils were recorded in both the treated group-A and B on various stages of 15 days interval evaluation (p<0.05) post treatment compared to group-C control camels and within group comparison to pre-treatment. Whereas, significant decrease in the mean lymphocyte count was recorded in the treated group-A and B on various stages of 15 days interval evaluation (p<0.05) post treatment compared to group-C untreated control camels and within group comparison to pre-treatment. Low levels of lymphocytes (<45 percent) recorded post treatment in the present study is in agreement with healthy camel values recorded by (Musa and Mukhtar, 1982; Rezakhani *et al*., 1997; Singh *et al*., 2000; Sharma, 2000; Gorakhmal *et al*., 2001 and Mali, 2002) [13, 16, 21, 18, 9, 12].

There was no significant difference in the total leucocyte, eosinophils, basophils and monocyte count were recorded between treated and untreated control groups either pre or post treatment. Singh (1993) [19] reported that in the pica affected camels TLC remained unaffected. Variations in the eosinophils counts from 1.2 to 4.53 percent have been reported (Dongre, 2000; Gorakhmal *et al*., 2001 and Mali, 2002) [5, 9, 12] in healthy camels. Basophils count of less than one percent in healthy camels has been reported by other workers (Rezakhani *et al*., 1997; Dongre, 2000; Gorakhmal *et al*., 2001 and Mali, 2002) [16, 5, 9]. In agreement to the present findings Singh (1993) [19] reported that in the pica affected camel monocyte count remained unaffected.

Biochemical parameters of the camels

Table 3: Comparative mean±SE values of biochemical parameters in healthy control group D with Group A, Group B and Group C on day 0 and day 60

Parameters	Healthy animal (Group-D)	Treated group (Group-A)		Treated group (Group-B)		Untreated group (Group-C)	
		0th day	60th day	0th day	60th day	0th day	60th day
Serum protein profile							
T.P. (gm/dl)	7.83^{C}±0.36	6.08^{D}±0.18	6.97^{D}±0.22	5.51^{D}±0.24	7.52^{C}±0.36	6.26^{D}±0.13	6.50^{D}±0.28
Albumin (gm/dl)	3.56±0.22	3.48±0.11	3.42±0.10	3.04±0.12	3.64±0.18	3.22±0.10	3.48±0.13
Globulin (gm/dl)	3.66^{C} ±0.20	2.59^{D} ±0.12	3.55^{C}±0.13	2.47^{D} ±0.16	3.88^{C}±0.19	3.03^{D}±0.08	3.01^{D}±0.18
A/G (ratio)	1.04^{C}	1.36^{D}	0.97^{C}	1.26^{D}	0.94^{C}	1.07^{C}	1.17^{D}
Liver enzymes							
SGOT/AST (IU/L)	55.24 ±6.45	43.66 ±8.90	50.97 ±9.08	71.48 ±4.87	63.26 ±8.41	46.00±8.87	60.37±10.25
SGPT/ALT (IU/L)	12.35 ±1.33	7.86±0.98	10.40 ±1.31	10.38 ±0.80	9.24±0.57	8.41±1.71	9.89±0.95
ALKP (IU/L)	169.47 ±7.89	152.48 ±18.96	136.76 ±16.29	181.13 ±17.22	195.06 ±11.72	141.46 ±17.26	169.69 ±22.27

Note: Mean ±SE bearing different superscript (C, D) between treated and healthy control camels differ significantly (p<0.05).

In feeding trail experiment, significantly low in mean±SE serum total protein and globulin were recorded in the both treated groups A and B and untreated group C on day 0 (pre-treatment) compared to healthy control group D. A/G ratio of treated group A and B and was significantly increased compared to healthy control group D on day 0. Mean serum total protein was recorded significant decrease in the treated group-A and untreated group C on day 60 (post-treatment) compared to healthy control group D (p<0.05) whereas in group B it was significantly similar with healthy control group D. A/G ratio of treated group A and B was significantly similar to healthy control group D on day 60 whereas A/G ratio of untreated group C was significantly increase compared to healthy control group D on day 60. Liver enzymes and albumin protein showed no significant difference in both the treated (groups A and B) and untreated control (group C) on day 0 and 60 (pre and post-treatment) compared to healthy control group D. In healthy camels, similar serum globulin concentrations of 3.41±0.18 (2.78-3.94) gm/dl were reported by Rathod (2006) [15], whereas high globulin concentrations of 4.66±0.16 (3.72-5.31) gm/dl were reported by Dongre (2000) [5]. Koted (2019) [11] recorded decrease in total protein and globulin levels in the pica affected camels as compared to treated and healthy camels.

Table 4: Comparative mean±SE values of protein profile and liver enzymes in Group A, Group B and Group C at different intervals of treatment

Parameter	Treated group (Group-A)					Treated group (Group-B)					Untreated group (Group-C)				
	0th day	15th day	30th day	45th day	60th day	0th day	15th day	30th day	45th day	60th day	0th day	15th day	30th day	45th day	60th day
T.P. (gm/dl)	6.08^{a}±0.18	6.30^{aA}±0.22	6.46^{aA}±0.22	6.82^{bA}±0.19	6.97^{bA}±0.22	5.51^{a}±0.24	6.13^{bA}±0.14	6.50^{bA}±0.22	7.01^{bB}±0.28	7.52^{bB}±0.36	6.26±0.13	6.26^{A}±0.09	6.34^{A}±0.13	6.41^{A}±0.19	6.50^{A}±0.28
Range	5.22-6.38	5.66-7.28	5.75-7.34	6.38-7.47	6.31-7.69	4.44-6.22	5.88-6.78	6.03-7.47	6.22-7.84	6.34-8.34	5.81-6.59	6.03-6.59	5.94-6.84	5.78-7.13	5.56-7.44
Albumin (gm/dl)	3.48±0.11	3.45±0.14	3.44±0.12	3.48±0.10	3.42±0.10	3.04±0.12	3.25±0.09	3.35±0.11	3.52 ±0.13	3.64±0.18	3.22±0.10	3.30±0.08	3.34±0.08	3.42±0.11	3.48±0.13
Range	3.05-3.81	2.97-3.97	3.05-3.93	3.26-3.89	3.19-3.75	2.69-3.55	2.97-3.62	3.02-3.79	3.19-3.96	3.05-4.13	2.97-3.57	3.05-3.57	3.11-3.72	3.15-3.83	3.16-3.88
Globulin (gm/dl)	2.59^{a}±0.12	2.85^{aA}±0.10	3.02^{bA}±0.10	3.34^{bA}±0.09	3.55^{bB}±0.13	2.47^{a}±0.16	2.87^{bA}±0.10	3.15^{bA}±0.16	3.49^{bB}±0.17	3.88^{aB}±0.19	3.03±0.08	2.96^{A}±0.05	2.99^{A}±0.06	2.99^{A}±0.11	3.01^{A}±0.18
Range	2.17-2.94	2.58-3.31	2.70-3.41	3.10-3.60	3.12-3.94	1.75-2.91	2.60-3.16	2.79-3.68	2.97-4.08	3.27-4.22	2.84-3.37	2.83-3.11	2.83-3.20	2.63-3.29	2.40-3.58
A/G (ratio)	1.36^{a}	1.22^{bA}	1.14^{bA}	1.04^{bA}	0.97^{bA}	1.26^{a}	1.14^{bA}	1.08^{bA}	1.02^{bB}	0.94^{bB}	1.07	1.11^{A}	1.12^{A}	1.15^{A}	1.17^{A}
Liver Enzymes															
SGOT/AST (IU/L)	43.66±8.90	46.44±7.32	52.65±7.30	48.51±6.42	50.97±9.08	71.48±4.87	68.74±3.46	67.26±7.23	66.94±7.35	63.26±8.41	46.00±8.87	56.71±8.75	62.16±11.30	59.16±10.68	60.37±10.25
Range	21.91-79.18	27.15-69.72	37.74-78.48	26.63-66.96	34.92-85.38	49.67-84.86	56.48-81.36	34.13-87.30	33.17-80.58	30.99-81.63	24.01-72.39	36.49-89.31	32.65-95.68	30.47-88.16	33.26-90.01
SGPT/ALT (IU/L)	7.86±0.98	7.35±0.81	8.45±1.00	9.63±0.54	10.40±1.31	10.38±0.80	10.21±0.88	9.84±0.74	9.73±0.93	9.24±0.57	8.41±1.71	9.80±1.05	9.63±1.04	10.44±1.0	9.89±0.95
Range	4.37-11.61	5.06-10.39	4.71-11.71	7.94-11.82	5.94-13.62	8.29-13.01	7.19-12.45	7.25-12.13	7.07-13.18	7.07-10.56	4.28-15.71	6.71-13.88	6.11-12.77	6.55-13.53	7.63-13.44
ALKP(IU/L)	152.48±18.96	143.03±14.98	152.00±19.82	154.50±19.22	136.76±16.29	181.13±17.22	190.07±9.35	177.81±9.60	191.19±6.29	195.06±11.72	141.46±17.26	154.20±16.22	178.85±13.82	179.81±17.75	169.69±22.27
Range	91.94-214.06	91.12-187.54	100.37-209.30	81.33-218.28	104.73-193.94	103.22-220.73	167.54-227.26	154.22-217.79	176.80-219.29	150.38-228.48	86.360-180.34	100.50-196.93	145.38-225.49	113.56-235.96	96.83-244.12

Note: 1. Mean ±SE bearing different superscript (A, B) between treated and control group differ significantly (p<0.05)
2. Mean ±SE bearing different superscript (a, b) within treated group differ significantly (p<0.05).

There was significant increase in the mean total protein and globulin in the treated group-A and B on various stages of 15 days interval evaluation post treatment compared to group-C untreated control camels and within group comparison to pre-treatment. Whereas, no significant difference in the mean albumin value and A/G ratio either within or between the treated and untreated control groups was recorded. But within treatment group-A significant decrease in A/G ratio was observed on various stages of 15 days interval evaluation post treatment compared to day 0. There was significant decrease in the mean A/G ratio in the treated group-B on various stages of 15 days interval evaluation post treatment compared to day 0 and compared to group-C untreated control camels. (p≤0.05).

In the present study, lymphocytosis with compensatory neutropenia and decrease in total protein and globulin suggests compromised immunity in pica affected camels. A:G ratio was significantly low in both the treatment groups, which was either because of only increase in globulin concentrations or corresponding decrease in albumin concentrations shows rectification of compromised immunity in the treated groups.

No significant difference in AST, ALT and alkaline phosphatase concentrations were recorded in both pre-treatment vs. post treatment and treated vs. untreated control groups. Aytekin *et al*. (2011) [3] found no change in ALT and AST concentrations between pica affected and non-affected horses.

Conclusion

Haematological examination of pica affected camels revealed low level of erythrocyte count, haemoglobin concentration and packed cell volume. Differential leucocytic counts revealed lymphocytosis and neutropenia in the pica affected camels. Significant decrease in total protein and globulin levels were recorded in the pica affected camels. A:G ratio becoming low in both the treatment groups, either because of only increase in globulin concentrations or corresponding decrease in albumin concentrations shows rectification of compromised immunity in the treated groups. In the untreated control group, A: G ratio was comparatively higher. Liver function tests (SGOT, SGPT and ALKP) reflect no liver damage in pica affected camels. These became normal by supplementation mineral mixture and salt and there was significantly improvement in animals treated with mineral mixture with salt supplementation. Based on haemato-biochemical parameters, effect of additional salt supplementation with mineral supplementation in the pica affected camels was found better.

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