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HAEMATOLOGICAL AND BIOCHEMICAL CHANGES IN CAMELS VACCINATED AND/OR INFECTED WITH CAMEL POX VIRUSES

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SUMMARY

Blood haematological, biochemical and immunological alterations were investigated before and after vaccination of camels with camel pox (CP) vaccine and/or infection with virulent CP virus (VCPV). The experiments were done on twelve, one-humped camels aged 18-24 months which were clinically healthy and free from antibodies against camel pox in their sera and divided into four groups. They were kept under observation and strict isolation measures. The haematological, biochemical and immunological results correlate and confirm each other and proved that changes after vaccination or infection with pox viruses started one week post inoculation and reached the peak at the 4th week and their levels differ in the different groups. Depending on the obtained results, the diagnosis and differentiation between the different conditions of (non vaccinated, vaccinated, infected after vaccination or infected with pox virus) could be easily detected in camels.

INTRODUCTION

The one-humped camel (Camelus dromedaries) was domesticated 3000 B.C. in Southern Arabia (Buillet, 1975). In Egypt, camel form an important part of domestic livestock population and their meat constitutes an important source of animal protein especially after the appearance (induction) of bovine spongiform encephalopathy (prion) disease in cattle in other countries.

Camel has received very little attention if compared with other species of domestic animals. Camel pox (CP) is one of the most important infectious and contagious disease, it causes by orthopox virus (Munz, 1992 and Gitao, 1997). The disease has a considerable economic importance due to its high morbidity, a relatively high fatality rate in young camels, loss of condition and weight

in all ages and decrease milk production in lactating animals (Pandey et al., 1985), in addition, it is suspected that CP is transmissible to man, thus creating a potential risk to handlers (Kriz, 1982). The occurrence of CP outbreak at several countries was recorded in India, Pakistan, Iran, Afghanistan and USSR (Borisovich, 1973), Somalia (Kriz, 1982), Kenya (Munz et al., 1986b and Gitao, 1997), Bahrain (Higgins et al., 1992), Saudi Arabia (Alhendi et al., 1994 and Gabery et al., 1997), Sudan (Khalafalla and Mohamed, 1996), and United Arab Emirates (Wernery et al., 1997).

In Egypt, the disease was recently reported by Zaitoun et al. (2000). Scanty data about the haemtological and serum constituents of camels were reported by Barakat and Abd El-Fattah (1970), Bokore (1974), Higgins (1986), Manaa (1990), Agag et al. (1993) and Hassan and Magda (2000).

The literature concerning the haematological and biochemical changes after vaccination or infection with camel pox gave little or no data, which leaves it open for research. Thus in this study, we tried to cover some haematological, biochemical and immunological changes in non-vaccinated, vaccinated and/or infected camels with pox viruses.

MATERIAL AND METHODS

1-Animals:

Twelve, susceptible male camels of 18-24 months old were selected for this study. They were obtained from El-Sharkia governorate, and were kept under observation for 3 weeks before being used. The animals were examined daily and were given balanced ration and water. They were divided into four equal groups, the 2nd and 3rd ones were vaccinated with camel pox vaccine (CPV), each camel was inoculated intradermally (I/D) with one ml (containing log 103 TCID50), while the 1st and 4th groups were left as unvaccinated control. All of the camels were kept under hygienic condition. One month post vaccination, the 3rd (vaccinated) and the 4th (non-vaccinated) groups were injected (I/D) with an infective dose of the virulent camel pox virus (Egyptian strain) containing 100 infective virus particles, while the other groups were left uninfected. All animals were kept under general clinical observation, with recording of body temperature.

2- Viruses:

a. Camel pox vaccine:

A tissue culture attenuated camel pox vaccine (Saudi strain) was obtained from Pox Research Department, Veterinary Serum and Vaccine Research Institute (VSVRI), Abbassia, Cairo, Egypt.

b. Virulent camel pox virus:

Egyptian virulent camel pox virus was obtained from Pox Research Department, VSVRI, Abbasia, Cairo, Egypt and used for experimental infection of the different camel groups.

3-Anti-camel whole serum:

Developed in rabbit, delipidized whole antisera, it was supplied by Sigma, USA, product No. c-7540 lot 058F4836. It was used in Enzyme Linked Immunosorbent Assay (ELISA).

4- African Green Monkey Kidney Cell Line (Vero):

It was obtained from Pox Research Department, VSVRI, Abbassia, Cairo, and used in virus neutralization test (VNT).

5- Blood and serum samples:

Blood and serum samples were regularly collected from the animals before and after inoculation with camel pox viruses for haematological, biochemical and immunological studies.

6- Haematological studies:

Blood samples were used for determination of haemoglobin, according to Archer and Jefcot (1977), erythrocytes, total and differential leucocytic counts according to the standard techniques described by Schalm et al. (1975).

7- Biochemical assays:

Sera of different groups of camels were examined for biochemical monitoring parameters, in which the amino transferases (AST and ALT) were done according to Reitman and Frankel (1957), urea by Tabacco (1979), creatinine by Husdan and Rapoport (1968), total and electrophoretic pattern of proteins according to Weichselbaum (1972), Davis (1964) and Ornistein (1964).

8- Immunological Tests:

The sera were also examined for detection of antibody titer against camel pox using:

a) **Virus neutralization test (VNT):** according to Martin et al. (1975).

b) **Enzyme linked immunosorbent assay (ELISA) technique:** according to Almoudallal et al. (1983).

RESULTS

Clinical Signs:

After experimental infection the vaccinated camels gave no localized or generalized reactions, while the control, non-vaccinated camels showed severe local reaction which was associated with rise of body temperature (2-3°C), loss of appetite and the typical stages of pox infection appeared on it and the dry scabs were detached 3 weeks post infection.

Table (1) Means of blood picture in vaccinated and control camels

Parameter	Time					
	7 days		15 days		30 days	
	Control	Vaccinate	Control	Vaccinate	Control	Vaccinate
Haemoglobin gm%	12.00 ± 1.69	11.63 ± 1.19	12.32 ± 1.23	12.00 ± 1.14	12.13 ± 1.21	11.75 ± 0.65
RBCs (Million/cmm)	7.85 ± 0.11	7.48 ± 0.60	7.95 ± 0.18	7.65 ± 0.53	7.80 ± 0.22	7.73 ± 0.41
Total WBCs (Thousand/cmm)	10.22 ± 0.55	12.05 ± 0.36	10.53 ± 0.46	11.16 ± 0.52	9.38 ± 0.17	9.75 ± 0.80
Neutrophils%	53.50 ± 2.28	59.00 ± 3.20	55.20 ± 2.83	59.25 ± 2.28	57.00 ± 3.71	59.5 ± 4.35
Lymphocytes%	36.50 ± 1.06	31.10 ± 2.14	34.30 ± 1.35	31.10 ± 2.46	33.5 ± 2.50	30.25 ± 3.20
Monocytes%	4.90 ± 0.71	5.75 ± 0.50	5.30 ± 0.44	5.50 ± 0.40	4.50 ± 0.41	5.25 ± 0.53
Eosinophils%	4.60 ± 0.35	3.80 ± 0.38	4.70 ± 0.35	4.15 ± 0.54	4.00 ± 0.38	4.50 ± 0.53
Basophils%	0.50 ± 0.22	0.33 ± 0.25	0.50 ± 0.35	0.50 ± 0.29	0.60 ± 0.20	0.50 ± 0.29

N.B. No Significant variation between the results recorded 2 and 3 weeks post vaccination.

Table (2) Means of blood picture in vaccinated and/or infected and control camels one week post infection.

Parameter	Groups			
	Non-vaccinated non-infected	Vaccinated	Vaccinated and infected	Infected
Haemoglobin (gm%)	12.20 ± 0.55	12.38 ± 1.08	13.40 ± 1.25	10.60 ± 1.11
RBCs (Million/cmm)	7.80 ± 0.38	7.35 ± 0.23	7.35 ± 0.47	6.75 ± 0.38
Total WBCs (Thousand/cmm)	10.25 ± 0.25	10.30 ± 0.46	11.70 ± 0.30	13.10 ± 0.55 **
Neutrophils%	48.00 ± 3.19	51.50 ± 2.83	53.50 ± 5.33	63.00 ± 4.10 *
Lymphocytes%	42.50 ± 3.71	38.00 ± 1.20	36.00 ± 2.41	28.25 ± 2.00 *
Monocytes%	4.50 ± 0.40	5.20 ± 0.38	5.70 ± 0.40	6.00 ± 0.71
Eosinophils%	4.50 ± 0.35	4.00 ± 0.50	4.50 ± 0.54	3.00 ± 0.25
Basophils%	0.50 ± 0.25	0.50 ± 0.29	0.60 ± 0.20	0.70 ± 0.28

* Significant at $p < 0.05$ ** Significant at $p < 0.01$

Table (3) Means of blood picture in different camel groups two weeks post infection.

Parameter	Groups			
	Non-vaccinated non-infected	Vaccinated	Vaccinated and infected	Infected
Haemoglobin(gm%)	11.90 ± 0.66	12.10 ± 1.00	12.56 ± 0.52	11.05 ± 0.45
RBCs (Million/cmm)	7.85 ± 0.18	7.46 ± 0.27	7.32 ± 0.30	7.00 ± 0.21
Total WBCs (Thousand/cmm)	9.60 ± 0.63	10.65 ± 0.45	11.20 ± 0.25	13.60 ± 0.40 **
Neutrophils%	52.00 ± 2.12	51.50 ± 3.53	55.00 ± 2.60	59.00 ± 2.85
Lymphocytes%	38.00 ± 1.71	38.00 ± 2.12	35.50 ± 1.75	30.00 ± 1.12 *
Monocytes%	5.70 ± 0.41	6.00 ± 0.20	6.00 ± 0.50	6.50 ± 0.53
Eosinophils%	4.00 ± 0.35	4.00 ± 0.33	3.50 ± 0.35	3.50 ± 0.28
Basophils%	0.33 ± 0.25	0.50 ± 0.29	0.00 ± 0.00	0.90 ± 0.0

* Significant at $p < 0.05$ ** Significant at $p < 0.01$

Table (4) Means of blood picture in different camel groups four weeks post infection

Parameter	Groups			
	Non-vaccinated non-infected	Vaccinated	Vaccinated and infected	Infected
Haemoglobin(gm%)	12.50 ± 0.63	12.45 ± 1.22	12.26 ± 0.56	12.12 ± 0.43
RBCs (Million/cmm)	7.85 ± 0.35	7.60 ± 0.41	7.56 ± 0.25	6.25 ± 0.16
Total WBCs (Thousand/cmm)	10.25 ± 0.71	10.13 ± 0.23	11.37 ± 0.56	12.80 ± 0.35 *
Neutrophils%	54.00 ± 3.53	55.00 ± 3.20	57.00 ± 3.53	62.00 ± 3.20
Lymphocytes%	37.00 ± 2.12	36.00 ± 1.80	32.00 ± 2.12	28.50 ± 2.06 *
Monocytes%	4.00 ± 2.12	6.00 ± 0.47	6.50 ± 0.53	6.00 ± 0.61
Eosinophils%	5.00 ± 0.55	4.00 ± 0.40	4.00 ± 0.26	3.50 ± 0.20
Basophils%	0.30 ± 0.0	0.70 ± 0.35	0.50 ± 0.29	0.30 ± 0.0

* Significant at $p < 0.05$

Table (5) Means of serum biochemical parameters in vaccinated and non-vaccinated (control) camels.

Parameter	Time					
	1 week post vacc.		2 week post vacc.		4 week post vacc.	
	Control	Vacc.	Control	Vacc.	Control	Vacc.
Total proteins (gm/dl)	7.34 ± 0.35	7.18 ± 0.27	7.00 ± 0.25	7.43 ± 0.45	7.50 ± 0.39	7.88 ± 0.06
Urea (mg/dl)	15.52 ± 0.42	19.85 ± 1.10 **	14.79 ± 0.78	17.96 ± 1.23	16.38 ± 0.83	16.75 ± 0.47
Creatinine (mg/dl)	0.77 ± 0.038	0.69 ± 0.11	0.82 ± 0.008	0.88 ± 0.033	0.73 ± 0.028	0.84 ± 0.025
AST (U/L)	38.56 ± 2.03	46.75 ± 2.53*	36.50 ± 1.25	43.70 ± 2.33*	35.44 ± 1.57	37.00 ± 2.35
ALT (U/L	23.16 ± 1.12	25.75 ± 0.85	24.12 ± 1.13	26.10 ± 1.07	25.38 ± 0.77	26.35 ± 1.41

* Significant at $p < 0.05$ ** Significant at $p < 0.02$.
AST = Aspartate amino-transferase. ALT = Alanine amino-transferase.
N.B. No significant variation between the results recorded in the 2nd and 3rd week.

Table (6) Means of serum protein electrophoretic pattern in vaccinated and control camels

Parameter	Time					
	1 week post vacc.		2 week post vacc.		4 week post vacc.	
	Control	Vacc.	Control	Vacc.	Control	Vacc.
Albumin	40.99± 1.63	36.50± 1.78	39.26± 1.30	35.85± 1.27	40.95± 1.56	36.85± 1.02 *
Alpha globulins	12.30± 0.66	15.33± 0.54 **	12.41± 0.63	14.38± 0.44 *	11.23± 0.51	12.88± 0.62
α 1 globulin	6.12± 0.30	8.89± 0.48	7.28± 0.43	8.33± 0.56	6.05± 0.49	7.33± 0.46
α 2 globulin	6.18± 0.24	6.44± 0.13	5.13± 0.17	6.05± 0.35	5.18± 0.40	5.55± 0.50
Beta globulins	20.63± 1.60	19.08 ± 1.28	22.47± 1.03	20.31± 1.26	21.70± 1.00	20.05± 1.20
β 1 globulin	15.11± 0.58	14.24± 0.64	16.26± 0.55	14.31± 0.80	16.07± 0.82	15.41± 0.67
β 2 globulin	5.52 ± 1.65	4.84± 0.29	6.21± 0.48	6.00± 0.61	5.63± 0.44	4.64± 0.52
Gamma globulins	26.08± 1.20	29.09± 1.48	25.86± 0.83	29.46± 1.17 *	26.12± 1.23	30.22± 0.88 *
γ 1 globulin	20.06± 0.96	22.05± 1.10	20.43± 0.79	21.86± 1.19	20.99± 1.14	22.13± 0.92
γ 2 globulin	6.02± 0.28	7.04± 0.37	5.43± 0.24	7.60± 0.53 ***	5.13± 0.36	8.09± 0.25 ***
Total globulins	59.01± 1.63	63.50± 1.78	60.74± 1.30	64.15± 1.27	59.05± 1.56	63.15± 1.02 *
A/G ratio	0.69± 0.04	0.57± 0.05	0.65± 0.03	0.56± 0.03	0.69± 0.04	0.58± 0.02 *

* Significant at $p < 0.05$ ** Significant at $p < 0.02$. *** = Significant at $p < 0.001$.
N.B. No significant variation between the results recorded in the 2nd and 3rd week.

Table (7): Means of serum biochemical parameters in the different groups after infection.

Time	Parameter	Groups			
		Control	Vaccinated	Vaccinated and infected	Infected
1 week post infection (5 weeks post vaccination)	Total proteins (gm/dl)	6.67 ± 0.22	6.90 ± 0.24	6.83 ± 0.19	7.08 ± 0.31
	Urea (mg/dl)	17.40 ± 0.93	19.74 ± 1.13	21.14 ± 0.85*	24.76 ± 1.22 **
	Creatinine (mg/dl)	0.79 ± 0.22	0.83 ± 0.011	0.81 ± 0.024	0.86 ± 0.026
	AST (U/L)	36.18 ± 1.28	39.20 ± 1.19	49.50 ± 1.64	67.28 ± 3.45 ***
	ALT (U/L	28.23 ± 1.05	30.12 ± 1.98	31.75 ± 1.20	33.24 ± 1.88
2 weeks post infection (6 weeks post vaccination)	Total proteins (gm/dl)	6.90 ± 0.36	6.54 ± 0.29	6.78 ± 0.22	7.55 ± 0.26
	Urea (mg/dl)	18.10 ± 1.12	19.33 ± 0.70	21.30 ± 1.12	30.16 ± 2.16 ***
	Creatinine (mg/dl)	0.85 ± 0.031	0.78 ± 0.052	0.81 ± 0.041	0.93 ± 0.041
	AST (U/L)	34.17 ± 0.89	38.58 ± 1.55	48.70 ± 2.23	72.05 ± 3.43 ***
	ALT (U/L	25.50 ± 0.83	28.10 ± 1.84	29.44 ± 0.77	35.70 ± 2.11 **
4 weeks post infection (8 weeks post vaccination)	Total proteins (gm/dl)	6.90 ± 0.23	6.87 ± 0.33	6.67 ± 0.25	7.53 ± 0.18
	Urea (mg/dl)	16.50 ± 0.74	18.10 ± 0.91	18.77 ± 0.73	23.02 ± 1.70 *
	Creatinine (mg/dl)	0.75 ± 0.018	0.85 ± 0.019	0.88 ± 0.044	0.89 ± 0.030
	AST (U/L)	33.57 ± 0.85	35.17 ± 1.11	41.37 ± 1.48	52.33 ± 4.08 **
	ALT (U/L	26.50 ± 0.55	25.86 ± 1.22	26.70 ± 0.39	30.15 ± 1.89

* Significant at $p < 0.05$ or $p < 0.02$. ** Significant at $p < 0.01$.

*** = Significant at $p < 0.001$.

Control = non-vaccinated non-infected (negative control).

Infected = non-vaccinated then infected (positive control).

Table (8): Means of serum protein electrophoretic pattern in studied groups 1 week post infection (5 weeks post vaccination).

Parameter	Groups			
	Negative control	Vaccinated	Vaccinated and infected	Infected
Albumin	38.23 ± 1.50	36.16 ± 1.46	33.85 ± 1.20	32.16 ± 1.41 *
Alpha globulins	12.74 ± 0.70	13.37 ± 0.75	14.88 ± 0.57 *	15.7 ± 0.79 ***
α 1 globulin	7.09 ± 0.53	6.76 ± 0.38	8.84 ± 0.27	8.31 ± 0.35
α 2 globulin	5.65 ± 0.32	6.61 ± 0.42	6.04 ± 0.35	7.39 ± 0.21 ***
Beta globulins	21.89 ± 0.77	20.06 ± 1.17	20.83 ± 0.95	18.58 ± 1.71
β 1 globulin	16.26 ± 0.83	15.72 ± 0.83	14.15 ± 0.26	14.27 ± 0.45
β 2 globulin	5.63 ± 0.18	4.34 ± 0.40	6.68 ± 0.53	4.31 ± 0.52
Gamma globulins	27.14 ± 1.39	30.41 ± 1.70	30.44 ± 1.82	33.57 ± 1.48 **
γ 1 globulin	20.81 ± 1.05	21.62 ± 1.25	21.11 ± 1.09	25.23 ± 1.27 *
γ 2 globulin	6.33 ± 0.45	8.80 ± 0.35 ***	9.33 ± 0.43 ***	8.34 ± 0.24 ***
Total globulins	61.77 ± 1.50	63.84 ± 1.46	66.15 ± 1.20	67.84 ± 1.41 *
A/G ratio	0.62 ± 0.04	0.57 ± 0.03	0.51 ± 0.03	0.47 ± 0.04 *

* Significant at $p < 0.05$ ** Significant at $p < 0.02$. *** = Significant at $p < 0.01$.
Negative Control = non-vaccinated and non-infected.
Infected = non-vaccinated then infected (positive control).

Table (9) Means of serum protein electrophoretic pattern in different groups 2 weeks post infection.

Parameter	Groups			
	Negative control	Vaccinated	Vaccinated and infected	Infected
Albumin	39.76 ± 2.12	35.88 ± 1.05	35.17 ± 1.22	31.86 ± 1.02 *
Alpha globulins	12.09 ± 0.51	13.20 ± 0.85	15.11 ± 0.88 *	14.70 ± 0.62 *
α 1 globulin	6.79 ± 0.33	6.71 ± 0.37	8.45 ± 0.60	8.83 ± 0.39 *
α 2 globulin	5.30 ± 0.15	6.49 ± 0.41 *	6.66 ± 0.33 **	5.87 ± 0.26
Beta globulins	21.82 ± 1.10	21.48 ± 0.96	20.29 ± 1.11	17.47 ± 0.83
β 1 globulin	17.21 ± 0.73	16.48 ± 1.0	14.91 ± 0.56	13.21 ± 0.55
β 2 globulin	4.61 ± 0.22	5.00 ± 0.41	5.38 ± 0.56	4.26 ± 0.35
Gamma globulins	26.33 ± 0.98	20.69 ± 1.08 *	29.43 ± 0.94	34.97 ± 1.11 ***
γ 1 globulin	20.30 ± 0.77	20.69 ± 0.85	20.42 ± 1.36	25.42 ± 0.89 ***
γ 2 globulin	6.03 ± 0.56	8.75 ± 0.39	9.01 ± 0.45	9.55 ± 0.36 ***
Total globulins	60.24 ± 2.12	64.12 ± 1.05	64.83 ± 1.22	68.14 ± 1.02 *
A/G ratio	0.66 ± 0.07	0.65 ± 0.02	0.54 ± 0.03	0.47 ± 0.02 *

* Significant at $p < 0.05$ ** Significant at $p < 0.02$. *** = Significant at $p < 0.01$.
Negative Control = non-vaccinated and non-infected.
Infected = non-vaccinated then infected (positive control).

Table (10): Means of serum protein electrophoretic pattern in studied groups 4 weeks post infection (8 weeks post vaccination).

Parameter	Groups			
	Negative control	Vaccinated	Vaccinated and infected	Infected
Albumin	38.39 ± 1.23	37.65 ± 0.94	34.62 ± 1.48	31.33 ± 2.33 *
Alpha globulins	13.80 ± 0.72	13.04 ± 0.84	13.53 ± 0.51	14.96 ± 0.66
α 1 globulin	7.75 ± 0.58	7.16 ± 0.41	6.85 ± 0.69	7.86 ± 0.45
α 2 globulin	6.05 ± 0.31	5.88 ± 0.47	6.68 ± 0.56	7.10 ± 0.37
Beta globulins	20.03 ± 1.00	19.77 ± 1.18	19.78 ± 0.70	19.31 ± 0.74
β 1 globulin	15.54 ± 0.63	14.40 ± 0.88	14.99 ± 0.59	14.19 ± 0.49
β 2 globulin	4.49 ± 0.22	5.37 ± 0.63	4.79 ± 0.33	5.12 ± 0.33
Gamma globulins	27.78 ± 1.15	28.54 ± 1.31	32.07 ± 1.15 *	34.40 ± 1.34 **
γ 1 globulin	22.18 ± 1.36	22.37 ± 0.85	23.23 ± 0.79	23.40 ± 1.11
γ 2 globulin	5.60 ± 0.16	7.17 ± 0.46 **	8.84 ± 0.50 ***	11.0 ± 0.55 ***
Total globulins	61.61 ± 1.23	62.35 ± 0.94	65.38 ± 1.48	68.67 ± 2.33 *
A/G ratio	0.62 ± 0.03	0.60 ± 0.02	0.53 ± 0.04	0.46 ± 0.07 *

* Significant at $p < 0.05$ ** Significant at $p < 0.02$. *** = Significant at $p < 0.01$.
Negative Control = non-vaccinated and non-infected.
Infected = non-vaccinated then infected (positive control).

Table (11) Means of neutralization indices (NI) of serum samples in different groups of camels.

Groups	Weeks post vaccination								
	0	1st	2nd	3rd	4th*	5th	6th	7th	8th
I	0.3	0.2	0.4	0.5	0.5	0.5	0.5	0.5	0.5
II	0.4	0.8	1.3	2.4	2.7	2.6	2.6	2.5	2.5
III	0.3	0.9	1.4	2.3	2.8	2.5	3.0	3.0	3.0
IV	0.4	0.4	0.3	0.3	0.5	1.1	2.6	3.1	3.7

* = Challenge (experimental infection) time.
Group I = Control non-vaccinated and non-infected group.
Group II = Vaccinated with camel pox vaccine (CPV).
Group III = Vaccinated with camel pox vaccine then infected (challenged) with the virulent camel pox virus (VC PV).
Group IV = Susceptible (not vaccinated but infected with (VCPV) [control infected group].
N.B. NI ≥ 1.5 is considered protective (Cottral, 1978).

Table (12): Means of ELISA titre in serum samples in different groups of camels

Groups	Weeks post vaccination								
	0	1st	2nd	3rd	4th*	5th	6th	7th	8th
I	360	360	355	370	365	370	370	375	370
II	376	994	1530	2535	2509	2559	2498	2512	2534
III	369	877	1603	2615	2352	2040	3000	3334	3958
IV	380	375	385	390	385	875	2990	3016	4658

Group I = Control non-vaccinated and non-infected group.
Group I = Vaccinated with camel pox vaccine (CPV).
Group III = Vaccinated with camel pox vaccine then infected (challenged) with the virulent camel pox virus (VC PV).
Group IV = Susceptible (not vaccinated but infected with (VCPV) [control infected group].
N.B. –ve = Zero → 800 ± ve = 801 → 1500. +ve = 1501 → 2500
High +ve = > 2500.

DISCUSSION

The camel is a triple-purpose animal providing milk, meat and transport; it also provides hair and hide in some area. In a world rapidly running out of food and of energy sources, the camel must provide at least a partial answer to some of the problems. The clinical signs after vaccination and/or infection with camel pox viruses, proved that the vaccinated camels withstood the experimental infection with virulent camel pox viruses, while the clinical signs of pox infection were appeared on the non-vaccinated susceptible camels, which was in agreement with (Amira, 2001).

The haemogram of the clinically healthy male camels (Table 1) showed that the mean value of the haemoglobin content and the RBCs counts were similar to those reported by Higgins (1986), Abd El-Samee (1987), Karram et al. (1991) and Al-Ani et al. (1992). Comparing the haematological results obtained in tables (2, 3 and 4) indicated that the haemoglobin content and RBCs count were differed after infection with camel pox virus in the different groups, and a non significant decrease in RBCs count was reported in the infected group. The possible explanation for these interrupted changes specially in the infected group (Group IV) were clarified by the findings of Abd El-Samee (1987) and Karram et al. (1991) who reported a similar decrease in RBCs count.

The total leucocytic count in the blood of the camels in the 1st group (clinically healthy camels) was (10.25 ± 0.25 thousand/cmm), the corresponding count was reported by Al-Ani et al. (1992). Tables (2, 3 and 4) demonstrated a significant increase in the total leucocytic counts, neutrophils and monocytes and a decrease in the lymphocytes and eosinophils in the infected camels

(Group IV) which was appeared from the 1st week post infection with the virulent camel pox virus and persisted to the 4th week, while non significant changes occurred in the vaccinated and those infected after vaccination (Groups II and III). There are no variation in the basophils within the different groups. Monitoring the available literatures concerning the infection with other pox viruses, Agag et al. (1997) reported a similar differential leucocytic count in sheep. In contrary Abd El-Samee (1987) recorded an increase in the eosinophil %, lymphocyte %, monocyte % and decrease in neutrophil % and basophil % in case of trypanosomiasis in dromedary camels.

The results of serum analysis for biochemical constituents were illustrated in tables (5 and 7). The serum total protein levels of dromedary camels vaccinated and/or experimentally infected with camel pox viruses recorded slight significant increase, which could be attributed to the concomitant elevation of gamma globulin specially in the infected group (Group IV) (Tables 8, 9 and 10) as stimulated by the viral antigens which previously reported by (Agag et al., 1989 and Tawfik et al., 1999).

The significant rise in the levels of serum urea in the 3rd and 4th groups which were infected with the virulent camel pox virus beside the non significant increase of the creatinine levels might be the result of degenerative changes in the kidney and liver (Tables 5 and 7). Visek (1972) demonstrated that the serum urea level depends largely upon the capacity of liver for detoxification of ammonia.

The significant increase in serum AST and ALT activity specially among the infected camels (Table 7) explain the degree of liver damage (Sutta and Vszgula, 1969).

The electrophoretic pattern of serum protein (Tables 6, 8, 9 and 10) gave also an evidence of changes in most fractions and subfractions between the different groups of camels and clearly appeared in the infected camels (Groups III and IV); the albumin values were decreased while the globulins were increased, resulting in reduced albumin/globulin ratio in vaccinated and infected camels which might be attributed to the protein abnormality and production of antibodies in gamma fraction (Yadav and Kalra, 1987). The significant increase in total alpha-globulins was due to acute inflammatory disease (Kaneko, 1989). On the other hand, beta-globulin which is responsible for iron transport and heme binding was decreased. Gamma-2 globulin achieved a highly significant increase in vaccinated and infected camels. The increment of globulins fractions specially gamma-globulins may due to the stimulation of the body defense mechanism to the antigen of camel pox. Therefore, immunological activity of the host is indicated by the presence of a high increase in globulin fraction particularly gamma globulin (Barabas et al., 1981).

Serological tests monitored by neutralization test and ELISA, for detection of specific antibodies against CP virus indicated that the neutralizing index (NI) was appeared on the 2nd week post vaccination or infection and persist up to the 8th week. A clear variation between the different conditions was recorded. These results agree with Kaaden et al. (1992), Gabery et al. (1997) and Amira (2001).

The camels infected after vaccination (Group III) recorded a high antibody level (NI = 3.0), while the highest level appeared in the infected group (Group IV) (NI = 3.7) which agree with Kalra et al. (1982).

Table (12) indicated that the ELISA titre differ in different groups and the highest titre (4658) was also reported in the infected group (Group IV), over than that calculated in the 3rd group (3958) which was infected after vaccination or in the vaccinated group (2534) and equal (370) in the susceptible non vaccinated camels. These results were in agreement with Munz et al. (1986 a) who reported that the diagnosis of camel pox is confirmed by the serological tests through the detection of antibodies against it by ELISA.

Comparison of the results had led to the conclusion that the haematological, biochemical or immunological studies may help as a mean of diagnosis and differential diagnosis between the vaccinated, vaccinated and/or infected camels with pox viruses, which was applied in this study for the first time in Egypt.

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