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HAEMATOLOGICAL AND BIOCHEMICAL STUDIES IN CAMELS INFESTED WITH *TRYPANOSOMA EVANSI* IN SOME AREAS OF SINAI.

BY

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ABSTRACT

The aim of this study was investigation of hematological and biochemical changes associated with *Trypanosoma evansi* in camels. A total number of 145 blood samples were collected by jugular vein puncture from dromedary camels of both sexes aged from 2 – 9 years and from private owners of camels in some villages of North Sinai Governorate. Stained blood smears were prepared from all blood samples and examined microscopically to demonstrate *Trypanosoma evansi* parasite. Card agglutination test for T.evansi (CATT) is suitable for detection of early infections or late infections with recent circulation of parasites in the blood and can detect active infections with high positive predictive value. Parasitological examination recorded 12 (8.3 %) of camels were positive while 133 (91.7 %) of camels were negative while CATT recorded 62 (42.8 %) were positive and 83 (57.2 %) were negative. The estimated blood parameters include RBCs, HB %, PCV %, MCV, MCH, MCHC % and both total and differential leucocytic counts. Serum biochemical analysis include total protein , albumin, globulin (α , β, γ) levels , aminotransferases (AST, ALT) activities , in addition to total bilirubin, urea , creatinine , glucose , iron , sodium , potassium , calcium and inorganic phosphorus levels. Hematological examination of positive samples for Trypanosomiasis showed a significant decrease in erythrocytic count, hemoglobin concentration, packed cell volume accompanied by a significant increase in total leucocytic count, neutrophils and esinophils with significant decrease in lymphocytes. The biochemical analysis revealed a significant increase in total protein, globulin especially γ-globulin levels, aminotransferases (AST, ALT) activities , total bilirubin, urea, creatinine as well as sodium

and potassium levels. A significant decrease was recorded for albumin, glucose, calcium and inorganic phosphorus levels.

In conclusion, *Trypanosoma evansi* infection in camels showed damaging effects harmfully manifested on different hematological and biochemical parameters of infected camels.

Key words: *Trypanosoma evansi*, camels, anemia, hematological and biochemical parameters.

INTRODUCTION

Camel is one of the best adopted animals of the desert, a source of milk, meat, wool and hides and is used for transportation and racing (**Kamal, 2008 and Meiloud et al., 2011)**.According to the last Official Egyptian Veterinary reports 267,000 camels live in Egypt belonging to the one humped species Camelus dromedaries **(Abdel-Rady, 2008).** Trypanosomiasis is an important protozoan disease of domestic animals that affects many species of mammals in Africa, Asia and Latin America constituting a serious threat to live stock production (**Neils et al., 2006 and Omer et al., 2007).** Trypanosomiasis is the most widely distributed pathogenic animal trypanosome affects cattle as well as other species including wild ruminants and dogs **(Kashemsant et al., 1989 and Indrakamhang et al., 1996).**

Trypanosomiasis is the most economically important disease of camel herds with morbidity of up to 30 % and mortality of around 3 % **(Enwezor and Sackey, 2005).**

It causes great losses in infected camels due to severe wasting effect on body weight, drop in milk production, infertility and abortion of pregnant females **(Igbokwe, 1994).**

Camel Trypanosomiasis, also known as Surra, is a disease caused by *Trypanosoma evansi* that constitutes one of the major veterinary problems worldwide. This disease is transmitted from camel to camel by a number of species of haematophagous biting flies including Tabanus, Stomoxys and Haematobia **(Chaudhary and Iqbal, 2000).**

The highest percentage of infection occurs during summer and the lowest in winter **(Mahran, 2004).** Trypanosomiasis in camels may occur in both acute and chronic forms but generally the chronic form is more common **(Gutierrez, et al., 2005).** The acute form of the

disease is usually fatal within a few weeks and is characterized by anorexia, dullness and rapid loss of condition, edema which may develop along the neck and abdomen, pregnant female may be aborted. Abortion occurs during all stages of pregnancy and the reproduction potential of the affected camels is greatly reduced **(Schuster, 2006).** While the chronic form lasts for years and is more common and characterized by anemia, emaciation, recurrent fever, edema, conjunctivitis, lacrimation, enlarged lymph nodes and abortion (**Sehrawat and Singh, 2006).**

In addition marked reduction in the thickness of hump and harsh coat which is likely to be associated with secondary infection due to immunosuppression **(Nijru et al., 2004 and Abdullah et al., 2006).** So, the susceptibility to ectoparasites such as mange or ticks increases. Moreover, the affected camel is often more susceptible to other diseases especially pneumonia **(Abo-Zeid, 2003).** Many investigators have shown alterations in the blood constituents and tissue lesions in the infected camels **(Al-Qarawi et al., 2001 and Saleh et al., 2009).** As haematobiochemical aspects are of considerable importance in diagnosis, prognosis and treatment. The present study was aimed to investigate the effect of Trypanosomiasis on some different haematobiochemical and immunological changes in adult dromedary camels.

MATERIAL AND METHODS

I - Animals (Camels):

This study was performed on 145 one- humped dromedary camels of both sexes and aged from 2 – 7 years old in the period from July 2013 until February 2014, kept by local owners in Sinai. After parasitological examination, 12 positive samples represent the infected group and divided into 8 heavy infested and 4 light infested according to the number of Trypanosomes in the microscopic fields, whereas 10 of the negative samples represent the control group.

II – Samples and adapted methods:

Blood samples:

Two blood samples were collected from each camel through jugular vein puncture. The first with anticoagulant used for hematological examination and the other without anticoagulant is used for separation of serum which used for biochemical, serological and immunological assay according to **Jain (2000).**

III – Diagnostic procedures:

(a) Clinical examination: All camels under study were subjected to clinical examination such as body temperature, mucous membrane, muscles of thigh and hump. The main complaints of the camel owners were loss of appetite, decrease of productivity and reduction of the body weight.

(b) Laboratory diagnosis:

1 – Parasitological examinations:

The easiest technique for detection of Trypanosomes in peripheral blood is by direct microscopic examination of blood, either by wet film method to detect motile Trypanosomes or stained thick and thin smears and this method can improved by concentration of the parasites by centrifugation. Peripheral blood is obtained by puncturing a small vein in the ear or tail. Deeper samples are taken from larger vein by syringe, an area of the ear or tail is first cleansed with alcohol and must be used disposable instruments between individual animals to prevent transmission of infection.

Wet blood films:

A small drop of blood is placed on to a clean glass slide and covered with a cover-slip to spread the blood as a monolayer of cells. This is examined by light microscopy to detect moving Trypanosomes, **(Nantulya, 1990)**.

Thick smears:

A large drop of blood is placed on the center of a microscopic slide and spread with the corner of another slide so that an area of approximately 1.0 - 1.25 cm in diameter is covered. This is air-dried for 1 hour and protecting from insects. The unfixed smear is stained by Giemsa for 25 minutes. After washing, the slides examined under a light microscope at high magnification x1000, **(Nantulya, 1990).**

Thin smears:

A drop of blood is placed 20mm from one end of a clean microscopic slide and a thin film is drawn. The film is air dried and fixed in absolute methanol for 2 minutes and allowed to dry. The smears are then stained by Giemsa for 25 minutes, washed in water and air dried. Slides are examined using microscopic oil at higher magnification**, (Nantulya, 1990).**

The slides were examined through 3 fields for detection of an extra cellular flagellated, spindle-shaped, motile Trypanosome with rapid twisting motion in blood film of camel. Levels of parasitemia were scored as +, + +, + + + and + + + + representing an average of 1 – 5 , 6 – 10 , 11 – 20 and > 20 parasites respectively seen per 3 microscopic fields **(Seifert, 1996 and Elaine and Margi, 2007).** In situations where only 1 parasite was detected after examining 3 microscope fields such were scored as very few (VF).

2- Hematological procedures:

Determination of total erythrocytic count, hemoglobin concentration, packed cell volume, and total and differential leucocytic counts were carried out according to **Jain (2000).** Thin and thick blood films were made from each blood sample, fixed in methanol and stained with Giemsa stain. The smears were examined microscopically for the presence of *Trypanosoma evansi* according to the method described by **Fleck and Moody (1993).**

3 – Biochemical studies :

Serum samples were colorimetrically analyzed using test kits (Bicon – Germany) for measuring serum total protein **(Hoffamann and Richterrich, 1970),** serum albumin **(Dumas et al., 1971),** serum glucose **(Siet et al. 1981),** serum urea **(Patton and Crouch, 1977)** serum creatinine **(Faulkner and King, 1976),** serum aminotransferases, AST and ALT **(Reitman and Frankel, 1957)**, serum total bilirubin **(Martinek, 1966)**, serum Iron **(Smith et al., 1981)** serum calcium **(Glinder and King, 1972)**, serum inorganic phosphorus **(Daly , 1972).** While serum sodium and potassium were determined using flame photometer **(Oser, 1979).**

Serological test, Card agglutination test (CATT): 4 -

It is well known that certain predominant variable antigen types (VATs) are expressed in common in different strains of Salivarian Trypanosomes from different areas. This finding was used as a basis for the diagnosis of T. evansi, the card agglutination test- CATT/*T.evansi.* The test is available in kit form from the OIE Reference Laboratory ITM. It consists of lyophilized stained parasites (antigen), PBS, PH 7.4, plastic-coated cards, spatulas, positive and negative control sera and a rotator. Serum samples were tested with CATT/*T. evansi* following the instructions of the manufacturer (Laboratory of serology, institute of tropical medicine, Antwerp, Belgium) according to **Bajyana Songa and Hammers, (1988)**. Briefly, one drop of camel serum diluted up to 1: 5 in CATT-buffer, was pipetted into a plastic coated

test card and then added with one drop of CATT reagent, the reaction mixture was spread out using a clean stirring rod and allowed to react on the card with help of manual rotation for 5 minutes. Blue granular agglutinations indicate a positive reaction visible to the naked eye.

5 – Immunological studies:

Protein electrophoresis was done using SDS-Polyacrylamide gel electrophoresis according to **Laemmli, (1970).**

IV – Statistical analysis:

The mean values obtained from hemograms and biochemical assays of positive samples were compared with data of negative control samples using the T- test **(Snedecor and Cochran, 1982).**

RESULTS

Clinical signs: Camels infested with Trypanosomes showed two forms, acute form of the disease which characterized by fever up to 40 º C lasting from few days to few weeks, oculo-nasal discharge , loss of appetite, dullness, loss of body condition , edema of the lower parts of the body and milk yields drop rapidly. In this form the parasite easy detected by microscopic examination after Giemsa stain blood smears. Whereas, the chronic form showed signs of inappetance, severe emaciation, weakness, the mucous membrane of conjunctiva become pale, atrophy of the muscles of the thigh, edematous swelling in testis , enlarged lymph nodes , lacrymation and thin of the hump and drop it to one side. The fever is recurrent with febrile paroxysms lasting from 5 – 7 days, corneal opacity may be seen.

Parasitological results : The Giemsa stain blood smears allowed detecting Trypanosomes parasite in 12 out of 145 camels 8.3 % , Fig (1).The infested camels were divided into 8 heavy infested and 4 light infested camels depends on the numbers of Trypanosomes in the examined fields.

Serological results: Card agglutination test (CATT) detected Trypanosomes antibodies in 62 camels out of 145 with a percentage of 42.8 %.

The results of parasitological and serological diagnosis of *T.evansi* in camels were summarized in table 1, while the results of hematological and biochemical changes of parameters were summarized in tables, 2, 3, 4 and 5.

Table 1: Parasitological and serological methods for detection of T. evansi infections in camels.

Test	Positive	Negative	Total
Parasitological	12 (8.3 %)	133 (91.7)	145
CATT	62 (42.8 %)	83 (57.2)	145

Table 2: Hematological profile of camels infested with Trypanosoma evansi compared with control group. (M ± SE)

Parameters	Positive for *Trypanosoma evansi* n=12	Negative for *Trypanosoma evansi* n=10
RBCs (x 10^6 /µl)	6.11 ± 0.20 *	9.16 ± 0.22
Hb gm %	8.86 ± 0.19 *	12.65 ± 0.20
PCV %	27.45 ± 0.54 * *	36.82 ± 0.46
MCV (fl)	*44.93 ± 1.27	40.20 ± 0.90
MCH (pg)	14.50 ± 0.23	13.81 ± 0.22
MCHC %	32.28 ± 0.20	34.36 ± 0.35

* Significant at (P< 0.05).

** Highly significant at (P<0.01).

Table 3: Leukogram of camels infested with Trypanosoma evansi compared with control group. (M ± SE)

Parameters	Positive for *Trypanosoma evansi* n=12	Negative for *Trypanosoma evansi* n=10
TLC (x 10^3/ µl)	17.58 ± 0.21 *	13.40 ± 0.10
Lymphocyte %	45.53 ± 0.62 **	51.71 ± 0.64
Neutrophils %	43.90 ± 1.56 *	39.79 ± 1.35
Eosinophils %	5.47 ± 0.32 *	2.93 ± 0.27
Monocytes %	4.30 ± 0.22	4.75 ± 0.24
Basophiles %	0.80 ± 0.31	0.82 ± 0.40

* Significant at (P< 0.05).

** Highly significant at (P<0.01).

Table 4: Some biochemical parameters in camels infested with Trypanosoma evansi compared with control group. (M ± SE)

Parameters	Positive for *Trypanosoma evansi* n=12	Negative for *Trypanosoma evansi* n=10
Total protein (gm /dl)	8.87 ± 0.24 *	6.95 ± 0.29
Albumin (gm/ dl)	3.54 ± 0.04 *	4.26 ± 0.03
Globulin (gm/dl)	5.33 ± 0.15 *	2.69 ± 0.28
α globulin (gm/dl)	1.60 ± 0.11	1.27 ± 0.02
β globulin (gm/dl)	1.38 ± 0.10	0.81 ± 0.10
γ globulin (gm/dl)	2.35 ± 0.02 * *	0.61 ± 0.02
A/G ratio	0.66 ± 0.20 *	1.58 ± 0.10
ALT (IU/L) activity	24.15 ± 2.10 * *	16.44 ± 1.53
AST (IU/L) activity	46.28 ± 2.41 * *	37.49 ± 1.60
T. Bilirubin (mg/dl)	1.72 ± 0.018 *	0.54 ± 0.017
Urea (mg/dl)	36.29 ± 1.86 * *	27.13 ± 1.55
Creatinine (mg/dl)	2.81 ± 0.06 *	1.20 ± 0.04
Glucose (mg/dl)	47.25 ± 2.21 * *	58.73 ± 1.20

* Significant at (P< 0.05).

** Highly significant at (P<0.01).

Table 5: Minerals concentrations in camels infested with Trypanosoma evansi compared with control group. (M ± SE)

Parameters	Positive for *Trypanosoma evansi* n=12	Negative for *Trypanosoma evansi* n=10
Iron (µg/dl)	76.32 ± 2.65 * *	94.12 ± 3.47
Sodium (mEq/L)	152.84 ± 2.29 * *	136.7 ± 2.25
Potassium (mEq/L)	6.43 ± 0.35 *	4.28 ± 0.52
Calcium (mg/dl)	9.86 ± 0.20 *	12.41 ± 0.75
Inorganic Phosphorus (mg/dl)	3.27 ± 0.16 *	5.88 ± 0.17

* Significant at (P< 0.05).

** Highly significant at (P<0.01).

DISCUSSION

I – Clinical, Parasitological and Serological examinations:

The clinical manifestation of Trypanosomiasis in animals is influenced by the host as well as Trypanosome species. Some infected animals undergo spontaneous recovery so the diagnosis of Trypanosomiasis cannot be based on clinical signs alone. The standard laboratory method for diagnosis of *Trypanosoma evansi* in camels is to demonstrate and identify Trypanosomes in the blood of the infected animals **(Nantulya, 1990).** However, the advantage of thick smear is that concentrate the blood in the small area, and thus less time is required to detect the parasites. On the other hand, thin blood film permits detailed morphological studies and identification of Trypanosome species. The clinical signs of *Trypanosoma evansi* in camels that recorded in this study were in agreement with that recorded by **Abdel-Rady (2008) and Padmaja (2012).** Published clinical signs (emaciation, fever, anemia, lacrimation, corneal opacity, diarrhea and edema of the dependent parts) are insufficient for diagnosis **(Chaudhary and Iqbal, 2000)** while detection of parasites in the blood is difficult because parasitaemia is intermittent **(Nantulya, 1990).**

Parasitological methods used for diagnosis of camel Trypanosomiasis are unsatisfactory **(Godfrey and Killick-Kendrick, 1962)** who recorded those parasitological methods detected only 50 % of infected animals, because infection with Trypanosomes in camels is usually in chronic form during which they exhibit very low parasitaemia**. Raisinghan and Lodha (1980)** recorded parasitological methods used for detection of Trypanosomes are not sensitive enough for diagnosis of Surra in camel. The chronic form is most common and may present in association with secondary infections due to immuno-suppression caused by *T.evansi* infection which complicates clinical diagnosis.

In the present study, out of 145 examined camels, 12 were found positive for *Trypanosoma evansi* infection with an incidence of 8.3 %. Thin and thick blood smears revealed Trypanosomes in positive samples, Fig (1). The prevalence of *Trypanosoma evansi* obtained in this study was higher to those obtained by **Mottelib et al., (2005)** and **Abdel-Rady (2008)** who mentioned that 5.82 % and 4.1 %, respectively of camels in Egypt were found to be infected with *Trypanosoma evansi.* Low incidence 5.4 % was detected by **Elamin et al., (1998)** in Sudan. On the other hand, **Shah et al., (2004)** in Pakistan **,Chaudhary and Iqbal, (2000)** and **El-Haig et al.,(2013)** in Egypt recorded higher incidence of 13.72 % ,

10.67 % and 12 % respectively, of *Trypanosoma evansi* infection in camels. Variation of incidence of *Trypanosoma evansi* among camels may be attributed to the difference of locality, rate of exposure and insect reservoir.

Serological tests have been developed and evaluated for diagnosis of Trypanosomiasis in camels. The antibody- detecting tests such as the CATT /*T. evansi* **(Magus et al. 1978, Bajyana-Songa et al., 1987 and Njiru et al., 2004),** So that detection of infested camels by serological test CATT revealed 42.8 % positive and all parasitological camels were positive by CATT, this result revealed a good correlation with parasitological methods. These findings are similar with those obtained by **Njiru et al.,(2004**), **Gutierrez et al., (2005)** and **Abdel-Rady (2008)** who reported sensitivity of CATT test to parasitological methods varied from 86 to 100 % . However, **Pathak et al., (1997)** reported that CATT can be used to study the seroprevalence of *T.evansi* since it is simple, quick and field test.

II – Hematological examinations:

The results of the haemogram presented in Table (2), revealed a macrocytic, hypochromic anemia in the infected group as evidenced by decline in the value of Packed cell volume, hemoglobin concentration and erythrocytic count with an increase in MCV and MCH. This result was in agreement with that obtained with **Baraka et al., (2000) ; Ahmed et al., (2004); Al-Mujalli (2007) ; Azza (2008); Moustafa et al., (2009) and Abeer Abd El-Baky and Shaymaa Salem (2011).** However, **Ogunsanmi and Taiwo (2001)** recorded that the major cause of anemia in Trypanosoma infection had been mainly attributed to extra vascular haemolysis due to phagocytosis of erythrocytes by an expanded mononuclear phagocytic system (MPS) in the Trypanosoma-infected host. In addition to the lytic and destructive effect of Trypanosomal hemolysin and Salidase enzymes on the erythrocytes in the liver, spleen, lung, lymph nodes and bone marrow **(Anosa et al., 1997; Carlos et al., 2006 and Dessouky , 2006).**

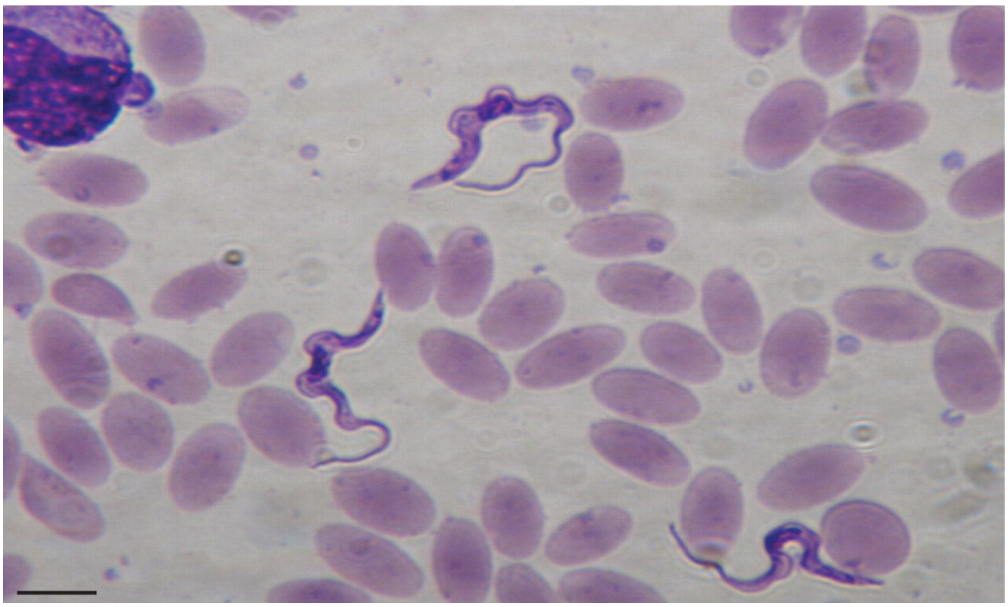

Fig 1 : An extracellular flagellated , spindle-shaped, motile Trypanosome with rapid twisting motion in blood film of camel.

Meanwhile, **Abeer Abdel-Baky and Shymaa Salem (2011)** attributed the presence of anemia in *Trypanosoma evansi* in camels to the enhanced oxidation of the erythrocytes which carried out by membrane injury, osmotic fragility and destruction of the cell during chronic *T.evansi* infection in camels. This concept agrees with that reported by **Gutierrez et al. (2005)** and **Akanji et al. (2009)**. The result obtained was confirmed by **Shahenaz (2007)** who recorded a general reticulocytosis in response to early haemolysis due to the increased extra vascular destruction of erythrocytes rather than inhibition of haemopoietic activity. A significant leucocytosis, neutrophilia, and eosinophilia were observed when comparing mean values of camel *T.evansi* positive group with those values of negative group (Table, 3). Leucogram showed also a significant decrease of lymphocytes in group of diseased camels comparatively with the negative group of camels for *T. evansi.* This result was in accordance with that obtained by **Chaudhary and Iqbal, (2000) and Padmaja (2012)** who indicated that decrease in lymphocytes in infected group with Trypanosomes was due to immune suppression. The eosinophilia observed is a feature of parasitic infections and is associated with immediate-type hypersensitivity reactions **(Enwezor and Sackey, 2005).** Similar results were obtained by **(Gutierrez et al. 2005; Hilali et al. 2006; Azza, 2008 Abeer Abd-El-Baky and Shaymaa Salem , 2011 and Padmaja, 2012).**

III - Biochemical and immunological examinations:

Evaluation of biochemical parameters gives good indication of functional state of various body organs. Where **Tizard (1996)** postulated that diseases caused by Trypanosomes induced the formation of high levels of systemic antigen-antibody immune complexes where their consequent deposition in the heart, liver, brain and kidneys may possibly play a role in tissue damage. However, some reports indicate that Trypanosomes can cause inflammation directly **(Silva et al., 1997).**Table (4) showed a significant increase in the values of serum total protein and serum globulin accompanied by a significant decrease of serum albumin and A/G ratio in camels with positive for *Trypanosoma evansi* when compared with negative camels with *T. evansi.* Similar results were obtained by **Gutierrez et al., (2005), Hilali et al.,(2006) and Moustafa et al., (2009)** in camels. The significant changes in serum proteins during Trypanosomes might be due to one or more of the following factors, either the destructive effect of the parasite on the hepatocytes leading to inadequate albumin production with consequent vascular escape of serum proteins **(Amal and Nabih, 1999 and Dessouky, 2006)** or as immune response against *Trypanosoma evansi* infection by increased serum levels of gamma globulin as immunological response against the parasite **(Orhue et al., 2005 and Hilali et al., 2006)** who indicated that serum albumin levels decreased in Trypanosomiasis. Protein electrophoresis showed a significant decrease in serum level of gamma-globulin in Trypanosoma infected group of camels comparatively with control group which could be associated with *Trypanosoma evansi* infection and lymphopenia **(Coles, 1986 and Hilali, et al., 2006).** An insignificant change in serum levels of Alpha and Beta globulins were recorded between the studied groups. The edema reported in the dependent parts of the body during the chronic stage could be due to a significant decrease in the albumin levels that possibly indicates great liver damage **(Enwezor and Sackey, 2005).** However, these changes in serum proteins were also reflected on A/G ratio which was significantly decreased in camels positive for *T.evansi* when compared with negative animals for the disease**, (Azza, 2008).**

Significantly increased serum values of ALT and AST activities were indicative of the Trypanosomiasis damaging effect on different organs that also attributed partly to cellular damage caused by *T.evansi* lyses or probably resulted from host destruction of Trypanosomes **(Enwezor and Sackey, 2005 and Hammad, 2008)** as shown in table (4). These results were in agreement with that obtained by **Amal and Nabih (1999); Ahmed et al. (2004)** and **Azza**

(2008) in camel. The association between ALT , bilirubin and albumin are indicative of hepatic dysfunction **(Boyd, 1988)** where a significant increase in total bilirubin was recorded in Trypanosome- infected camels (Table,4) as a result of enhanced erythrocytic destruction due to hemolysin and membrane injury **(Ogunsanmi and Taiwo, 2001 and Hilali et al., 2006).** However, **Biswas et al., (2001)** postulated that kidney is susceptible to blood diseases where toxins of parasite and accumulation of immune complex leads to impair the kidney function and structure, where, in the present study, a significant increase of serum urea and creatinine levels in camels infected with *T. evansi* were shown in table (4). This result was in accordance with **Gutierrez et al. (2005) and Al-Mujalli (2007)** who explained the effect of body protein destruction as well as the poor body condition leads to increased serum urea and creatinine levels in infected camels with *T.evansi.* Table (4) showed also a significant decrease in serum glucose level in infected camels comparatively with control group , where hypoglycemia is a common change that occur during Trypanosomiasis infection which is mainly attributed to blood sugar consumption by the parasite as well as depletion of body glycogen **(Carlos et al. 2006 and Dessouky, 2006)**. It has been reported that Trypanosomes are capable of metabolizing aromatic amino acids forming toxic byproduct as phenylalanine which is catabolized to phenylpyruvate characterized by a proteolytic activity which may inhibit glycogenesis and mitochondrial function **(Igbokwe, 1994).**

Table (5) showed a significant decrease in serum iron level in Trypanosoma infected camels comparatively with apparently healthy camels. This result was in accordance with **Gutierrez et al. (2005)** in camels and **Neils et al. (2006)** in sheep. Such decrease could be attributed to malabsorption through the degenerated intestinal mucosa of Trypanosome infected camels **(Amal and Nabih, 1999),** in addition to decreased iron-transporting protein ferritin as suggested by **Chaudhary and Iqbal (2000).**

Table (5) showed also a significant increase in serum sodium and potassium levels in infected group when compared with the control group. These results were in agreement with **Amal and Nabih, (1999)** and **Azza (2008)**. This increase in serum sodium is most often concerned with water retention and the resultant edema **(Rose, 1984).**

A significant decrease in serum calcium and inorganic phosphorus levels were recorded in Trypanosoma infected camels (Table, 5). These results were in agreement with that obtained with **Amal and Nabih (1999), Al-Mujalli (2007)** and **Azza (2008)** in camels.

However, **Anosa (1988)** suggested that calcium in conjunction with phosphorus depressed thyroid cells, but the actual roles of calcium and phosphorus during Trypanosomiasis are not yet known. Meanwhile**, Amal and Nabih (1999)** referred this decrease in serum calcium and inorganic phosphorus levels to malabsorption of these elements as a result of degenerative changes of the intestinal mucosa associated with Trypanosomiasis. Recently, **Neils et al. (2006)** recorded a reduction in ATP production in infected animals which could probably reflect the effect of decreased phosphorus levels.

In conclusion, *Trypanosoma evansi* infection in camels caused major changes in the hematological and biochemical parameters. These changes were responsible for the devastating effects of the disease on the animals. Card agglutination test for *T.evansi* (CATT) is suitable for detection of early infections or late infections with recent circulation of parasites in the blood and can detect active infections with high positive predictive value. So, this study is a trial to clarify the different damaging effects of *Trypanosoma evansi* infection as reflected on different hematological and biochemical parameters in camels, triggering for the need of a continuous surveilling international program including treatment and eradication of the vector. As animal Trypanosomiasis still constitutes a serious threat to livestock production in Africa, resulting in adverse impact on health, productivity and working capacity of camels.

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الملخص العربى

دراسات هيماتولوجية و بيوكيميائية فى الجمال المصابة بالتريبانوسوما ايفانساى فى بعض المناطق بسيناء

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يهدف هذا البحث الى دراسة بعض التغييرات الدموية و البيوكيميائية المصاحبة للاصابة بطفيل الدم المعروف باسم تريبانوسوما ايفانساى فى الجمال . هذا وقد تم تجميع عدد ١٤٥ عينة دم من الوريد الودجى من جمال وحيدة الصنام من كلا الجنسين تتراوح اعمارها من ٢ – ٧ سنوات من بعض مربى الجمال بسيناء وبخاصة محافظة شمال سيناء . وباجراء الفحص الميكروسكوبى لعينات الدم تم رصد عدد ١٢ من العينات الخاصة بالجمال ايجابية الاصابة بطفيل التريبانوسوما ايفانساى بنسبة حدوث ٨,٣ ٪ بينما باقى العدد ١٣٣من الجمال و يمثل ٩١,٧٪ كانت سالبة الاصابة لهذا الطفيل بينما كان اختبار بطاقة التلازن هو الاختبار المناسب لاكتشاف الاصابة المبكرة والمتاخرة للطفيل فى الدم حيث سجل اختبار بطاقة التلازن عدد ٦٢ جملا بنسبة ٤٢,٨ ٪ كانت موجبة الاصابة بالتريبانوسوما ايفانساى بينما ٨٣ جملا بنسبة ٥٧,٢ ٪ كانت سالبة . وقد اجريت التحاليل الدموية على كلا المجموعتين و قد اظهرت نقصا معنويا فى كل من عدد خلايا الدم البيضاء و الخلايا المتعادلة و خلايا الاسينوفيل فى المجموعة الايجابية للاصابة بمقارنتها بالمجموعة السالبة كما اظهرت التحاليل البيوكيميائية زيادة معنوية فى مستويات كل من البروتين الكلى و الجلوبيولين و بخاصة الجاما جلوبيولين ونشاط انزيمات الامينوترانسفيريز ، البيلوروبين الكلى ، اليوريا ، الكرياتينين بالاضافة الى الصوديوم و البوتاسيوم كما ظهر نقصا معنويا فى مستويات كل من الالبيومين ، الجلوكوز ، الحديد ، الكالسيوم و الفسفور فى مجموعة الجمال ايجابية الاصابة بمقارنتها بالمجموعة السالبة لهذا الطفيل.