

Parasites of the one-humped Camel (*Camelus dromedarius*) in the Sudan: A review.

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Summary

In the Sudan the one-humped camel (*Camelus dromedarius*) is affected by many parasites. These include protozoans, helminths and ectoparasites. The most important diseases that threat camel health in the country are trypanosomosis, mange and haemonchosis. Camel is also infected with coccidiosis, toxoplasmosis, sarcocystosis, tapeworms, hydatidosis, and ticks and nasal myiasis.

Summary

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Introduction

The one-humped camel (*Camelus dromedarius*) is the most numerous animal in semi-arid and arid tropical areas of Africa. It is emerging as a valuable animal in the Sudan. Camel population in the Sudan exceeds 3.1 millions heads (Schwartz, 1992; Anon, 2000) being second to Somalia worldwide. It is owned mainly by migratory pastoralists and camel represents a good source of milk, meat, wool, hair and hides. More recently in 1995, a racing camel in the Eastern region of the Sudan was priced at 2 million Sudanese dinars.

The important role of the camel has inspired investigators and researchers to look for diseases that may threaten camel health and production. Although, a number of parasitic diseases have been

reported to affect the camel in different localities in the Sudan, three major seriously debilitating diseases, namely mange “Jarab”, haemonchosis “Hulaa” and trypanosomosis “Guffar” are problematic, though well known by the camel owners (Dafalla *et al.*, 1987). The causative agents of the parasitic diseases of camels may be grouped under the following categories:

1/ Protozoan parasites .2/ Helminth parasites. 3/ Ecto-parasites.

(1)Protozoan parasites

Although a number of protozoan parasites including *Trypanosoma*, *Theileria*, *Eimeria*, *Toxoplasma*, *Hommondia* and *Sarcocystis* have been reported to infect camel worldwide, five of these parasites were reported from Sudanese camels.

(i) *Trypanosoma evansi*:

Camel trypanosomosis, caused by *Trypanosoma evansi*, is the most serious disease affecting camel (Higgins, 1983, Dakkak and Ouhelli, 1987). *T. evansi* was firstly identified in the Sudan from donkeys, mules and camels as early as 1904 (Balfour, 1904). Since then information has accumulated gradually over the years from natural and experimental infections, as well as from chemotherapeutic trials (Knowles, 1929; Bennet, 1931; Evans, 1952, Priestly, 1953-54 and Karib, 1961). The disease is widespread in the Sudan (Luckins *et al.*, 1979) and known locally as “Guffar” (Karib, 1961). All camels regardless of age, type or sex are susceptible to *T. evansi* infection. In the country both acute and chronic forms of the disease occur. The acute form is usually fatal and affected animal may die within 3-4 weeks or even after one year. Chronically infected camels harbour trypanosomes for 3-4 years. Some camel herders claimed that infected camels may develop characteristic urine odour which could be used as diagnostic parameters (Mahmoud and Osman, 1979). Hunter (1986) stated that the urine of affected camel has a strong pungent odour and is dark brown in colour. Death may occur during the first or second year (Rutter, 1967).

T. evansi is mechanically transmitted from animal to animal by haematophagous biting flies (Karib, 1961; Higgins, 1983) including *Tabanus species* (Mahmoud and Gray, 1980). In the Sudan seven species of tabanids were recorded (Yagi and Razig, 1972a; 1972b and Razig and Yagi, 1975), namely *Tabanus taeniola*, *T. buguttatus*, *T. gratus*, *Ancala latipes*, *Atylotus agrestis*, *Atylotus fuscipes* and

Philoliche mgretti. The flies were found to be common throughout the year, however, the outbreaks of *T. evansi* infection occur during the rainy season (June to October) due to higher flies densities (Mahmoud and Gray, 1980). Cattle, sheep, goats and donkeys undergo a protracted *T. evansi* infection, may become carriers and act as reservoir hosts and thus they may play a role in the epidemiology of the disease in camels (Malik and Mahmoud, 1978).

Many diagnostic techniques including parasitological and serological means were devised. The techniques differ in their reproducibility, specificity and sensitivity and each can be applied according to the present situation required (in the field or in the laboratory). Techniques in use for diagnosis of camel trypanosomosis in the Sudan include blood smears from peripheral circulation (Bennet, 1932), rodents inoculation (Godfrey and Killick-kendrick, 1962), haematocrit technique (Woo, 1969), detection in changes of serum enzymes level (Boid *et al.*, 1980), Indirect Fluorescent Antibody Test (Luckins *et al.*, 1979) and the use of ELISA (Luckins *et al.*, 1979; ElAmin *et al.*, 1993a). In the Sudan both antibody and antigen detecting ELISA (Luckins *et al.*, 1979; ElAmin *et al.*, 1993a) were used. Using the latter technique El Amin *et al.* (1993a) have reported an over all prevalence of 43% in mid-Eastern Sudan.

(ii) *Eimeria* species:

In the Sudan three species of *Eimeria* have been recorded and identified from camel in Eastern Sudan (Yagoub, 1989). These are *E. cameli*, *E. dromedarii* and *E. rajasthani*, of which *E. cameli* was found to be the most prevalent and most pathogenic (Yagoub, 1989).

(iii) *Toxoplasma gondii*:

Toxoplasmosis, is a sporozoan disease of all warm blooded species including man and birds caused by *T. gondii* (Blood and Radostits, 1989). Mammals act as intermediate hosts and members of the family felidae act as the final hosts (Solusby, 1982; Higgins, 1985).

Sero-epizootiological surveys that were carried out at different localities in the Sudan (El Badawi *et al.*, 1984; El Din *et al.*, 1985; Abbas *et al.*, 1988; Bronstein *et al.*, 1989; Elamin *et al.*, 1992) have indicated that toxoplasmosis is quite prevalent in camels. A preliminary serological study using Latex agglutination carried out in Butana area (mid-eastern Sudan) showed an overall prevalence of 61.7% which indicated that camel could act as intermediate host for *T.*

gondii. (Manal, 1996). The high level of seroconversion to toxoplasma may indicate a possible presence of the clinical disease among camel population in the Sudan. This situation may be related to possible changes in camel husbandry practices, that makes contraction of the disease easier.

Since *T. gondii* is known to cause abortion and neonatal calf mortality in cattle, sheep and goats. Transplacental infection and detection of tachyzoites in camels milk were investigated by Manal (2001a). Further studies to determine the pathogenicity and economic impact of *T.evansi* in camel as well as its public health hazards, especially among nomads who consume raw cameline milk (fresh and sour) and liver were suggested (Elamin *et al.*, 1992).

(iv) *Sarcocystis cameli*:

Sarcocystis cameli is the only species of the genus *Sarcocystis* reported from the camel (Warrag and Hussein, 1983; Higgins, 1985). The parasite encysts in the skeletal, oesophageal and cardiac muscles. In the Sudan two types of *S.cameli* were described by Manal *et al.*(2001b). Ginawi and Shommein (1977) reported a prevalence of 4.5% in Sudanese camels at postmortem using histopathological technique, where Hussein and Warrag (1983) have serologically found that 81% of the camels surveyed in Khartoum were positive for sarcocystosis. The difference in findings was probably due to the difference in methods of diagnosis used by the different investigators.

Sarcocystosis may lead to partial or total condemnation of the carcass. The pathogenic and economic significance of the disease in camels is not known at present, but it is well known that sarcocystosis may induce abortion in cattle (Levine, 1982). Moreover, encephalitis attributable to sarcocystis in goats was reported in the Sudan (Zakia *et al.*, 1988).

(v) *Hommondia heydroni*:

The only named parasite of ruminants of this genus is *Hommondia heydroni*. The one-humped camel was found to be one of the intermediate hosts of *H. heydroni* (Warrag and Hussein, 1983). The parasite has an obligatory heteroxenous life cycle with a final canine host (Duby and Williams, 1980).

It is infective only to dogs (Warrag and Hussein, 1983; Manal 1996) while cats were found to be refractory.

(2) Helminth Parasites:

Sudanese camels harbour a number of helminth parasites (Eisa *et al.*, 1979 and Eisa, 1991). Nematodes, cestodes and trematodes infecting Sudanese camels are well studied and documented (Steward, 1950; Eisa *et al.*, 1979)

(i) Nematodes:

Gastrointestinal Nematodes:

In the Eastern Sudan eight species of gastrointestinal nematodes were reported in three separate surveys by Kheir *et al.* (1982), Elamin *et al.* (1984) and Burger *et al.* (1989). These nematodes are *Haemonchus longistipes*, *Trichostrongylus probolurus*, *Trichostrongylus spp*, *Cooperia pectinata*, *Impalia tuberculata*, *Oesophagostomum columbianum*, *Trichuris globulosa* and *Setaria labiatopapillosa*. High infection was caused by *H. longistipes* (Elamin *et al.*, 1984). These authors attributed the increased prevalence of camel haemonchosis to changes in grazing behaviour (from feeding on upper bushes to feeding on grasses) as a result of removal of bushes, shrubs and trees for rain-fed mechanized crop production schemes. Thus increasing the chances of picking up of ova and/or larvae from pasture.

A positive correlation between rainfall and egg count, as well as high infection rate during the rainy season was revealed by Burger *et al.* (1989) in the Butana area (mid-eastern Sudan). Pasture infestation of camel-breeding area in the same region was studied by Magzoub *et al.* (1989) who revealed the presence of high number of *Trichostrongyle spp* and *Haemonchus spp*. *Haemonchus* Larvae were found to decrease towards winter and disappear completely in Summer as they were detected only during the rainy season. This question has been explained by Saleem (1992) who has detected hypobiotic larvae of *H. longistipes* in the abomasi of camels in Butana area during the dry season. The author concluded that *H. longistipes* in Butana area survives as both adult and arrested fourth stage larva (L4) during the hot dry Summer. This finding is so essential to be taken into consideration before the application of any successful control measures. *H. contortus*, on the other hand, was found to infect camels sharing grazing with sheep (Arzoun *et al.*, 1984):

Onchocerca species:

In the Sudan, onchocercosis in camel was investigated by Steward (1950), El Sinary and Hussein (1981), Atta el Mannan

(1988), Hussein *et al.* (1988) and Awad *et al.* (1990). Three species were reported so far: *O. fasciata* (Steward 1950), *O. gutturosa*, Bovine species (El Sinary and Hussein (1981) and *O. armillata* (Hussein *et al.*, 1988). A prevalence of 56% (28/50) of *O. gutturosa* in camel's ligamentum nuchae was recorded by Awad *et al.* (1990). *O. armillata* was reported from Dinder area only, while *O. gutturosa* is widespread in the Sudan (Hussein *et al.*, 1988). The pastoral co-existence of camel and cattle might have facilitated such cross transmission between different animal species (Hussein *et al.*, 1988; Awad *et al.*, 1990).

Microfilariae:

Camel filariasis was recently reported in 7 out of 14 camels examined at Khartoum North near the River Nile (Elamin *et al.*, 1993b) and the microfilariae displayed a biphasic pattern of periodicity.

(ii) Trematodes:

Fasciola and Schistosoma parasites:

Fasciola gigantica and *Schistosoma bovis* were reported from camels in the White Nile area (Karib, 1961). Kheir *et al.* (1982) have reported 2 camels infected with *Schistosoma bovis* in eastern Sudan. More recently Zakia *et al.* (1991) reported on the occurrence of cholangiocarcinoma associated with *F. gigantica* infection in a camel in Southern Darfur State (Western Sudan). However, the pathogenesis and pathogenicity of *Fasciola gigantica* in camel have not been studied.

(iii) Cestodes:

Camel in the Sudan were found to be infested with some cestodes. These include; *Avitellina spp* (Karib 1961; Siddig and El Hussein, 1997-1998), *Stilesia hepatica* and *S. viltata* (Steward, 1950; Karib, 1961 and Elowni *et al.*, 1986). *Moniezia expansa* was also recorded by Siddig and El Hussein (1997-1998).

Hydatid cyst:

Hydatidosis is a cyclozoonotic disease, widespread in the Sudan (El Khawad *et al.*, 1979). The metacestode of *Echinococcus granulosus*, hydatid cyst, was found in various tissues and organs. However, the predilection sites in camel are the lungs and liver (Saad, 1983; Saad and Magzoub. 1989; El Hussein *et al.*, 1991). Fertile cysts were found mainly in the lung as a primary site, with high fertility rate that ranged from 67.4% to 83.7% (Abdalla and Saad,

1995) compared to the liver in which it was less common and mostly sterile. Among ruminants, camels host the highest prevalence of hydatid cyst infection followed by sheep, cattle and goats (El Khawad *et al.*, 1979). El Sawi and Saad (1995) reported 43.9% prevalence for camel hydatidosis at Omdurman Slaughterhouse. This prevalence is not much different from those reported on a field survey in Central, Eastern and Western parts of Sudan (35.3% - 48.7%) by Abdalla and Saad (1995). In Kordofan State camel hydatidosis was investigated by Saad and Magzoub (1989) and by Saad *et al.* (1989). The number examined by the Saad and Magzoub (1989) was, however, too small to reflect the exact situation and Saad *et al.* (1989) reported a prevalence of 67.7%.

Hydatidosis in man was reported in the Southern States, Khartoum and Central States (Ali, 1962). In the Sudan a prevalence of 53% for *E. granulosus* in dogs surveyed in Khartoum area was recorded by Eisa *et al.* (1962). Camel plays a major role in the epizootiology of the disease in the Eastern, Western and Northern States, where it is the main domestic animal that lives in close contact with dogs and the study of the disease by Saad and Magzoub (1989) indicated that hydatidosis cycle in the Sudan is "Camel-dog-camel".

Diagnosis of hydatidosis is usually established at post mortem. Serodiagnosis by Indirect Haemagglutination Test (IHA) and Immunoelectrophoresis (IEP), was attempted (Saad and Hassan, 1989). IHA was found to be unreliable because it was non-specific, while IEP was highly specific but its sensitivity required some improvement.

3) Ecto-parasites:

The camel is exposed to and affected by different types of external parasites. Mites being the most important ones (Leese, 1927). Sarcoptic mange in camels is second to trypanosomosis in importance (Nayel and Abu-Samra, 1986). Other external parasites include ticks, flies, and nasal bots.

Sarcoptic scabiei:

In the Sudan camel mange is widespread (Nayel and Abu-Samra, 1986). The disease affects the skin regardless of type, age or sex and is locally called "Jarab". Camel mange is seasonal and is more common during winter and the rainy season (Leese, 1927). However, in the Middle East, the disease seems to peak during the

summer season (Higgins *et al.*, 1984). In an extensive survey of the Butana area, (mid –eastern Sudan) Nayel and abu-Samra (1986) reported an overall prevalence of 55.2%. Prevalence was high during winter(59%)and the rainy season (55%) and low during the summer(43.6%).The investigation of Bitter *et al.* (1986) in Rufaa' camels in Eastern Sudan coincided with the findings of Nayel and abu-Samra (1986) and showed a severe infestation during winter.

Diagnosis of mange is based on clinical signs, lesions and recovery and identification of mites in skin scrapings (Higgins,1985), however, the disease could be confused with ringworm and camel pox.

Ticks:

Tick infestations in camels have been recognized in the Sudan (Steward, 1950; Osman, 1977; Latif, 1985; Shommein and Osman, 1987; Yassir *et al.*, 1992). *Hyalomma m. rufipes*, *H. impeltatum*, *H. dromedarii*, *H. truncatum*, *Rhipicephalus simus* and the nymphal stage of *Amblyoma variegatum* were reported by Osman (1977) in Darfur State with *H. dromedarii* as being the most prevalent species that infests camels. *H. truncatum* was unexpected to feed on camels and sheep (Latif, 1985). Infestation was shown to be high during the rainy season.

Tick paralysis occurred as a sequel to heavy tick infestation and an acute outbreak of tick paralysis in camels was reported in Southern Darfur State by Musa and Osman (1990). These authors investigated 420 heads in 10 camel herds in three different areas and reported 59% morbidity,34.3% mortality and 42.2% recovery rates.

The disease is called “Abu Eggal”.Clinical signs included incoordination of movement, unsteady gait and recumbancy ending in death or recovery following tick removal.

Tick collected from pasture were mainly immature stages (Larvae and nymph) of *Hyalomma* and *Rhipicephalus spp.* Adults collected from camels were *H. rufies*, *R. evertsi* and *R. Turanicus*.

***Cephalopina titillator* (Nasal myiasis):**

The larval stage of *Cephalopina titillator* is an obligate parasite of camel. The adult fly deposits larvae in the nasal cavity where they may remain parasitizing the animal for a considerable period of time.In the Sudan the parasite was investigated by many

authors in different localities; Central Sudan (Steward, 1950), Southern Darfur (Musa *et al.*, 1989); Northern State (El Hussein and Taha

Personal communication), Eastern Sudan (Abdoon personal communication). Both sexes and different ages were involved (Musa *et al.*, 1989; A/El Rahim, unpublished data). In an outbreak of unknown aetiology with high morbidity and low mortality rates in Kassala State (Eastern Sudan), 2% of the necropsied camels showed maggots of *Cephalopina titillator* (A/El Rahim, unpublished data).

Conclusions

There is growing awareness of the unique role that camel plays in the cultural heritage and socio-economics of the Sudan. The increasing value of the camel, however, has verified the economic viability of health care. The most important is that, camel can tolerate harsh conditions and thrive better if good control means for the diseases affecting camels are adopted.

References

- Abbas, B.; Elzubeir, A.E.A. and Yassin, T. M. (1988). *Rev. Elev. Méd. Vét. Pays. Trop.* **40** : 231 – 233.
- Abdalla, H.S. and Saad, B.M. (1995). Camel Hydatidosis in the Sudan. XVII Int. Cong. Hydatidol. 1995. Limassol-Cyprus, A124.
- Ali, A.M. (1962). *Sudan J. Vet. Sci. Anim. Husb.*, **3**: 97-108.
- Anon. (2000). Annual Report of Department of Planning and Economics. Ministry of Animal Resources, Khartoum.
- Arzoun, I.H.; Hussein, S.H. and Hussein, M.F. (1984). *J. Comp. Path.*, **94**: 169-174.
- Atta el Mannan, A.M. (1988). *Sudan J. Vet. Res.* **8**: 71-72.
- Awad, M.A.M.; Osheik, A. A.; Tageldin, M.H. and Zakia, A.M. (1990). *Rev. E'lev. Méd. Vét. Pays Trop.*, **43**(3): 345-348.
- Balfour, A. (1904). Trypanosomiasis in the Anglo-Egyptian Sudan. Wellcome Research. Lab. 2nd Report. PP. 113 – 173.
- Bennet, S.C.J. (1928-1932). Annual Report of the Sudan Veterinary Service: (1928) P. 35-45; (1929) p. 33-39; (1930)p. 45-48; (1931)p. 30-32; (1932)p. 30-31.
- Bitter, H. (1986). Disease resistance in dromedaries with particular reference to *T. evansi* infection. Hannover, West Germany.

- Blood, D.C. and Radostitis, O.M.C. (1989). Sarcocystis and Toxoplasmosis In: Veterinary Medicine 7th edition. Bailliere Tindall, London pp. 1001-1007.
- Boid, R.L.; Mahmoud, M.M. and Gray, A. R. (1980). *Res. Vet. Sci.*, **28**: 336-240
- Bronstein, S.; Musa, B.E. and Jama, F.M. (1989). Proc. Int. Symp. Develop. Anim. Resour. Sudan. Khartoum 3-7 Jan. 1989. AOAD press. Khartoum, Sudan. PP. 28-34.
- Burger, H.J.; Fadl, M. and Magzoub, M. (1989). Proc. Int. Symp. Develop. Anim. Resour. Sudan. Khartoum 3-7 Jan. 1989. AOAD press. Khartoum, Sudan. PP. 54-57.
- Dafalla, E.I., ElGezuli, A.Y. and Saad, M.B. (1987). *Sud. J. Vet. Sci. Anim. Husb.*, **26**: 39-45.
- Dakkak, A. and Ouhelli, H. (1987). *Rev. Sci. Tech. Off. Inter. Epiz.*, **6**: 447-461.
- Duby, J. P. and Williams, S.F. (1980). *J. Parasitol.*, **81**:121-123.
- Eisa, A.M. (1991). Internal Parasites of domestic animals in the Sudan. 5th Vet. Med. Cong. Khartoum, 24 Nov. 1991. Khartoum, Sudan.
- Eisa, A.M.; El Khawad, S.E., Saad, M.B.A., Ibrahim, A.M. and El Gezuli, A.Y. (1979). *Sudan J. Vet. Res.* **1**: 55-63.
- Eisa, A.M. Mustafa, A.A. and Soliman, K.N. (1962). *Sudan J. Vet. Sci. Anim. Husb.*, **3**: 97-108.
- ElAmin, E.A., Elias, S., Dauschies, A. and Rommel, M. (1992). *Vet. Parasitol.*, **43**: 171-175.
- El Amin, E.A., El Hassan, E.M., El Bashir, M.O.A. and Luckins, A.G. (1993a). IAEA. Technical Document no. 707.pp. 111-119. Agency Vienna, June 1993.
- ElAmin, E.A., Mohamed, G.E.; Fadl, M., Saeham, Elias, Saleem, M.S. and Elbashir, M.O.A. (1993b). *Br. Vet. J.*, **194**:195-199.
- El Amin, M.A. Gaffar, Tageldin, M.H. and Yagoub, I.A. (1984). *Bull. Anim. Hlth. Prod. Afr.* **32**: 412-414.
- El Badawi, K.S., Machael, S.A. and Morsy, T.A. (1984). *J. Egy. Soc. Parastol.*, **14**: 289-293.
- El-Din, E.A.Z.; El Khawad, S.E. and Kheir, H.S.M. (1985). *Rev. E'lev. Méd. Vét. Pays Trop.* **38**: 247-249.

- El Hussein, A.M.; Hassan, N.; Taha, K.M. and Ali, S.M. (1991). *Sudan J. Vet. Res.* **10**: 63-64.
- El Khawad, S.E.; Eisa, A.M.; Slepnev, N.K. and Saad, M.B.A. (1979). *Bull. Anim. Hlth. Prod. Afr.* **27**: 249-251.
- ELOwni, E.E.; Gameel, A.A. and El Sanousi, S.M. (1986). *Sudan J. Vet. Sci. Anim. Husb.* **25**: 97-98.
- ElSawi, A.S. and Saad, M.A. (1995). Hydatidology in Sudan. In: XVII Int. Cong. Hydatidol. Limassol, Cyprus, A148.
- El Sinary, K. and Hussein, H.S. (1981). *Ann. Trop. Med. Parasitol.*, **75**: 469-470.
- Evans, J.T.R. (1952). Annual Report of the Sudan Veteinary Service, Khartoum, Sudan.
- Ginawi, M.A. and Shommein, A.M. (1977). *Sudan J. Vet. Sci. Anim. Husb.*, **18**: 92-97.
- Godfrey, D.G. and Killick-Kendrick, R. (1962). *Ann. Trop. Med. Parasitol.*, **56**: 14-19.
- Higgins, A.J. (1983). *Vet. Bull.*, **53**(12): 1089-1097.
- Higgins, A.J. (1985). *Br. Vet. J.*, **141**: 197-215.
- Higgins, A.J. Al Mazaini, S.A. and Abu Khamseen, A.M. (1984). *Vet. Rec.*, **115**: 15-16.
- Hunter, A.G. (1986). *Trop. Anim. Hlth. Prod.* **18**: 146-148.
- Hussein, S.H. and Warrag, M. (1983). *Sud. J. Vet. Sci. Anim. Husb.*, **24** (1): 57 – 63.
- Hussein, S.H.; Atta El Mannan, A.M., and El Sinary, K. (1988). *Vet. Res.Comm.* **12** (6): 475-480.
- Karib, E. (1961). *Sudan J. Vet. Sci. Anim. Husb.*, **2**(1): 39-46.
- Kheir, H.S.M.; Yagoub, I.A. and Elbadawi, F.S. (1982). Proc. 3rd pan-Afr. Vet. Conf. Khartoum, Sudan, 23-29.
- Knowles, R.H. (1929). *J. Comp. Path. Therap.*, **37**: 37-44.
- Latif, A.A. (1985). *Insec. Sci. Appl.*, **6**(1): 59-61.
- Leese, A.S. (1927). Diseases and parasites of the skin. A treatise on the one-humped camel. Haynes and Sons, Standford, Lincolnshire. PP. 335 – 347.
- Levine, N.D. (1982). In: P. L. Long (ed.). The Taxonomy and Biology of the coccidia. PP. 221.
- Luckins, A.G.; Boid, R.; Rae, P.; Mahmoud, M.M.; El Malik, K.H. and Gray, A.R. (1979). *Trop. Anim. Hlth. Prod.*, **11**: 1-12.

- Manal Y. Ishag. (1996). Studies on tissue cyst-forming coccidia from the one-humped camel (*Camelus dromadarius*) in the Sudan. M. Sc. Thesis, University of Khartoum
- Manal, Y. Ishag. (2001a). *Sudan J. Vet. Sci. Anim. Husb.* **40**: 75-82
- Manal, Y. Ishag. (2001b). *Sudan J. Vet. Res.* **17**: 27-33.
- Magzoub, M.; El Hassan, E.M. and Burger, H.J. (1989). The degree of pasture infection with trichostrongyle nematodes of camels in the Eastern Region of the Sudan. *Proc. Int. Symp. Develop. Anim. Resour. Sudan.* Khartoum 3-7 Jan. 1989. AOAD press. Khartoum, Sudan. pp. 58-61.
- Mahmoud, M.M. and Gray, A.R. (1980). *Trop. Anim. Hlth. Prod.* **12**: 35-47.
- Mahmoud, M.M. and Osman, M.O. (1979). A note on trypanosomosis in the Sudanese camel In: The camelid. An all purpose animal. *Workshop on camel*, Khartoum, December 1979. IFS provisional Report No. 6 (ed. R.W. cockril and Scandanavian Institute of African studies). Uppsala University, Sweden pp. 502 – 507.
- Malik, K.H. and Mahmoud, M.M. (1978). *Sudan J. Vet. Sci. Anim. Husb.* **19**: 47-57.
- Musa, M.T. and Osman, O.M. (1990). *Rev. Elev. Med. Vet. Pays Trop.* **43** (4): 505 – 510.
- Musa, M.T.; Harrison, M.; Ibrahim, A.M. and Taha, T.O. (1989). *Rev. E'lev. Méd. Vét. Pays Trop.* **42**(1): 27-31.
- Nayel, N.M. and Abu-Samra, M.T. (1986). *J. Arid Envir.*, **10**: 199-211.
- Osman, O.M. (1977). *Bull. Anim. Hlth. Prod. Afr.* **24**: 329-333.
- Priestly (1953–54). Annual Report of the Sudan Veterinary Service, McCorquodale and Co. Ltd., Khartoum, Sudan.
- Razig, M.T.A. and Yagi, A.I. (1975). *Rev. Zool. Afr.*, **89**: 117-123.
- Rutter, T.E.G. (1967). *Vet. Bull.*, **37**(9): 611-621.
- Saad, M.B. (1983). *Sudan J. Vet. Sci. Anim. Husb.*, **4**: 156.
- Saad, M.B. and Hassan, A.K. (1989). *Rev. Elev. Med- Vet. Pays Trop.*, **42**(4): 41 – 44.
- Saad, M.B. and Magzoub, M. (1989). *Sudan J. Vet. Sci.. Anim. Husb.* **28**: 27-32.
- Saad, B., El Sadig, Aisha A. and Shammam, A.M. (1989). *Sudan J. Vet. Sci. Anim. Husb.* **28**(2) 46.

- Saleem, M.S. (1992). Some aspects of the biology, epidemiology, pathology and diagnosis of *Haemonchus longistipes* infection in camels and goats. M.V.Sc. Faculty of Veterinary Science, University of Khartoum.
- Schwartz, H.J. (1992). In: The camel (*C. dromedarius*) in Eastern Africa. Verlag Josef Margraf, FR Germany. PP. 1-9.
- Shommein, A.M. and Osman, A.M. (1987). *Rev. Sci. Tech. Off. Inter. Epiz.*, **6**: 481-486.
- Siddig A.M. and El Hussein A.M.(1997-1998). *Sudan J.Vet.Res.***15**:38-42
- Soulsby, E.J. (1982). Helminths, Arthropods and protozoa of Domesticated animals. 7thed. Sailliere Tindall. Lonodn, pp. 686-687.
- Steward, J.S. (1950). *Vet. Rec.*,**62**:835-839.
- Warrag, M. and Hussein, H.S. (1983). *J. Parasitol.* **69**: 926-926.
- Woo, P.T.K. (1969). *Can. J. Zool.*, **47**: 921-923.
- Yagi, A.I. and Razig, M. T.A. (1972a). *Rev. Zool. Bot. Afri., Bru.*, **86**: 293-301.
- Yagi, A.I. and Razig, M. T.A. (1972b). *Rev. Zool. Bot. Afri., Bru.* **85**: 406-411.
- Yagoub, I. A. (1989). *J. Protozol.*, **36**(4): 422-423.
- Yassir, O.M.; Osman, O.M. and Elamin, T.H. (1992). *Insect. Sci. Appl.* **13**: 565-568.
- Zakia, A.M.; Osman A.Y. and Gasmir, G.S. (1988). *Sudan J.Vet. Res.*, **8**:39-42.
- Zakia, A.M.; Musa, M.T.; Osman, A.Y. and Osman, A.M. (1991). *Sudan J.Vet.Res.* **10**: 57-61.