TISSUE CYST FORMING- COCCIDIA FROM CAMELS (*Camelus dromedarius)* IN SUDAN: A REVIEW

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المستخلص

تلعب الجمال دوراً رئيساً كعائل وسيط لأنواع كثيرة من الكوكسيديا التي تسبب أكياس بالأنسجة. فالخلية البيضية الناضجة لكل من أنواع *Toxoplasma gondii* , *Cystoisospora felis* و *Cystoisospora rivolta* قد تم عزلها من القطط التى تمت تغذيتها تجريبياً بلحوم جمال مصابة. بينما عزلت أكياس بوغية من أنواع *Sarcocystis cameli* , *Sarcocystis spp*. و وخلية بيضية ناضجة من انواع *Cystoisospora ohieonsis* , *Hammondia hedorni* و *Cystoisospora burrowsi* من الكلاب. تمت مناقشة الإصابة بـــ *Toxoplasma* و *Sarcocystis* في الجمال بالسودان.

Abstract

Camels (*Camelus dromedarius*) in the Sudan act as intermediate host for many species of cyst forming coccidian parasites . Oocysts of *Toxoplasma gondii* , *Cystoisospora felis* and *Cystoisospora rivolta* were isolated from cats experimentally fed infected camel meat while sporocysts of *Sarcocystis cameli* , *Sarcocystis spp*. and oocysts of *Hammondia hedorni* , *Cystoisospora ohieonsis* and *Cystoisospora burrowsi* were isolated from dogs . Studies on *Toxoplasma* and *Sarcocystis* that were carried on camels in Sudan were discussed .

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Introduction

Most coccidia are believed to parasitize the intestine of only one host species ,they are monoxenous and oocysts are eliminated in the feces. However , Tissue cyst- forming coccidian are obligatory intracellular protozoa with a typical coccidian life cycle consisting of three alternating phases; that is, asexual multiplication by merogony (schizogony), sexual reproduction by gamogony and asexual reproduction by sporogony . Most species of tissue cyst-forming coccidian are obligately or facultatively heteroxenous; that is,both an intermediate and a definitive host need to be present for the life cycle of the parasite to be completed. Usually, the asexual phase of the life cycle (merogony) leads to the formation of tissue cysts in various tissues of the intermediate host, while the sexual phase of the life cycle (gamogony) leads to the formation of oocysts in the intestine of the definitive host .

Cyst forming coccidia includes the genera ;'*Sarcocystis, Toxoplasma, Hammondia, Cystoisospora, Neospora, Besnoitia and Frenkelia* . All of the cyst forming coccidia recognized so far from oocysts with two sporocysts each of which contains four sporozoites after sporulation. Morphologic attributes of tissue cyst forming coccidia have been defined and compared in an earlier study by Frenkel (1977).

Tissue cyst forming coccidia:

i-*Toxoplasma gondii:*

Although *T. gondii* has a worldwide distribution and perhaps the widest host range of any parasite, there is only one species, *gondii* in the genus *Toxoplasma* . It was first detected by Nicolle and Manceaux (1908, 1909) in a rodent *Ctenodactylus gondi*, and by Splendore (1908) in a rabbit . Knowledge of the full life cycle of *T. gondii* was not completed until 1970, when sexual phase of the lifecycle was identified in the intestine of the cat, by

demonstrating oocysts in cat faeces and characterizing them biologically and morphologically (Dubey et al. 1970*)* . *Toxoplasma gondii* is both monoxenous and heteroxenous coccidian parasite . It has an extremely wide range of intermediate hosts (mammals &birds) but a narrow range of final hosts (felidae) . Camel is one of mammals which acts as intermediate host for *Toxoplasma gondii* . In Sudan many studies were carried out at different locations (El Badawi et.al.,1984; El Din et. al.,1985; Abbas et. al.,1988; Bronstein et. al.,1989; Elamin et. Al.,1992 ; Manal et.al.,2005), the last attempt ravealed an overall prevalence of 61.7% in six different locations (El gedarif, North Kordofan, El shawak, River Nile, Butana and El hamra). A high prevalence rate was recorded in old animals , while high titers were detected in camels under one year of age. Khalil (2004) reported a prevalence of 30% in North Kordofan and 100% in camels herders in Butana . The first isolation of *Toxoplasma gondii* oocysts from cameline origin were carried out in Sudan (Manal, 1996) .The isolated oocysts measured 10.5-13.0um x9.0-11.0um.

A relationship between congenital toxoplasmosis and diarrhea in calf-camels were experimentally determined since transplacental toxoplasmosis in camesl was investigated (Manal et.al.,2006). The outcome of *Toxoplasma* infection varied according to the time of infection during pregnancy and the number of parasites inoculated .Anti-*toxoplasma* antibodies were detected in 51.3% diarrheic calf-camels less than one year of age recruited from three different locations in Sudan - Butana, Kordofan and River Nile-(Manal et.al.,2009) . The excretion of *Toxoplasma* gondii tachyzoites in milk of camel was studied by Intraprotoneal inoculation (IP) of albino mice with milk of experimentally infected she-camel ,*Toxoplasma* cysts were detected in brains of mice and the sulking calf-camels.

ii-*Sarcocystis*

Heydorn and Rommel (1972) ; Rommel et al(1972) , found that dogs and cats fed *Sarcocystis* cysts developed gamonts and oocysts in the lamina propria, and these oocysts, unlike previously known coccidia, sporulated in situ . *Sarcocystis* have an obligatory two –host life cycle ; Herbivores act as intermediate host that acquire infection by ingestion of sporocysts shed out in feces of infected definitive hosts(Carnivores) which become infected by ingestion of the encysted form of the parasite in the musculature of intermediate hosts (Dubey et al.1989). There is considerable confusion in the literature regarding speciation of Sarcocystis of camel. Originally a single species was thought to parasitize camel(Mason,1910; Abdel Gafar et. al., 1979; Hilali et.al.,1980).However,in Sudan, two types of *Sarcocystis* sporocysts were isolated from puppies which fed raw camel meat(Manal et.al.,1999), the isolated sporocysts measured(16.0 um x 9.9-11.5 um) and(13.2-13.6 um x6.5-9.5um) . On the other hand , two types of *Sarcocystis* tissue cysts were detected in muscles of experimentally infected camel (Manal et.al., 2006), one form measured 26.4-72.5 um x 9.9-29.5 um with a thin cyst wall , while the other cyst measured 73-155 um x23-29.5 um with a thick cyst wall , one type was identified as *Sarcocystis cameli* and the other one was designated as *Sarcocystis camelocanis*. Ginawi et.al.(1977) reported a prevalence of 4.5% in Sudanese camels histopathologically, where as Hussein &Warrag (1985) found a prevalence of 81% of anti-Sarcocystis antibodies in dogs in Khartoum . The pathological effects of *Sarcocystis* on camel were studied, anaemia , lethargy, unsteady gait and death were the main clinical signs that were noticed on camels experimentally infected with *Sarcocystis* sporoysts. Moreover, encephalitis attributed to *Sarcocystis* was reported (Manal et.al.(2001). From an economic point of view Sarcocystosis may lead to partial or total condemination of the carcass .

iii-*Hammondia heydorni*

Heydorn,(1973); Dubey and Fayer,(1976) described a parasite that cycle through dogs and named it *Hammondia heydorni* (Dubey, 1988). This parasite is morphologically similar to T. gondii but with a different life cycle. Unlike, *T. gondii*, it is non-pathogenic, and has an obligatory 2-host life cycle. Canine act as a final host while mammals act as intermediate hosts . Tissue cysts are formed in striated muscles of intermediate hosts. Camel in Sudan was found to be one of the intermediate hosts of *Hammondia heydorni* (Warrag et.al .,1983 ; Manal et.al.,1999). Those authors isolated *Hammondia heydorni* from puppies fed raw camel meat ,the isolated oocysts measured 10.0-13.um-9.0-11um .

iv-Cystoisospora

Cystoisospora is a coccidian parasite , has two hosts , dog acts as a final host for *Cystoisospora burrowsi* and *C. ohioensis* (Dubey, 1978) , and cat acts as a final host for *C.rivolta* and *C.felis* (Dubey, 1979). The parasite forms unizoic tissue cysts in the intermediate hosts (Dubey and Frenkel,1972;Frenkel,1977).

The studies carried on camels in Sudan demonstrated that , camel meat contains developmental stages of *Cystoisospora burrowsi* , *C. ohioensis* , *C.rivolta and C.felis* (Manal et.al.,2001) , the isolated oocysts from dogs and cats which fed raw camel meat measured 18.0-19.5um x 15.5-18.9um, 20.8-26.5um x 16.6-22.0um, 20.0-28.0um x 18.0-21um and 36.5-45.0um x 26.0-37.0um, respectively (Manal et.al. 2000).

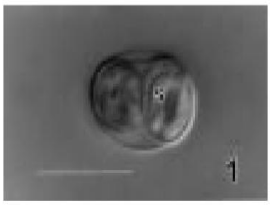
v-*Neospora*

Neospora caninum is a recently recognized protozoan parasite of animals, which until 1988 misidentified as *Toxoplasma gondii* (Dubey et al. 2002).Its veterinary importance became known a few years later when it was found to cause abortion in cattle and clinical disease in many other species of a nimals

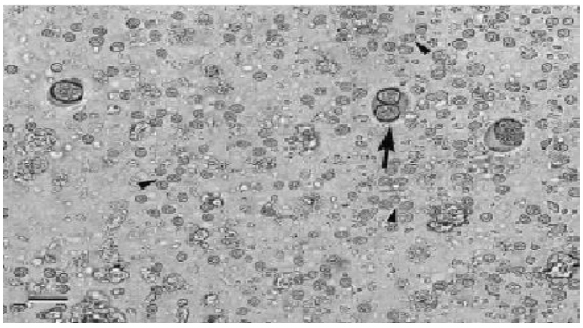
(Dubey et al. 2007). Its oocyst was discovered in 1998 when dogs, but not cats, fed tissue cysts, shed oocysts (McAllister et al. 1998). . Unlike,*T. gondii,N.* caninum is regarded as a major pathogen of cattle and dogs it has a wide host range but its zoonotic potential is unknown.Dogs act as final host while cattle, goats,horses, camels and chicken act as intermediate hosts (Dubey et al. 2007).Now many studies are going on to determine camel neosporosis in Sudan, but results are not published yet .

Conclusion

It is clear from the above discussion that camel meat contains developmental stages of at least nine species of tissue cyst forming coccidian parasites , dogs act as a final host for some of them while cats act as a final host for the other.The high seroprevalence of Toxoplasma gondii reported in pastoral camels and camels herders in Sudan warrants a closer look into its economic impact. So, further studies to determine the coccidian strains as well as its economic impact and public health hazards are recommended especially among nomads who consume raw camels milk and liver. On the other hand , dogs and cats rearing should be controlled so as to cut off life cycles of the cyst forming coccidian parasites



Toxoplasma gondii unsporulated oocysts



2

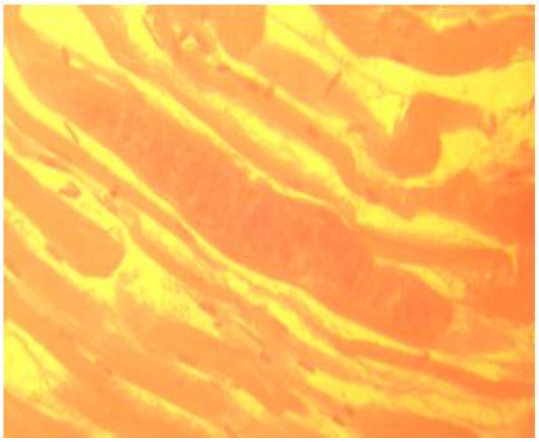
Toxoplasma gondii sporulated oocysts (arrowheads) and (*Isospora felis*) (arrows in a fecal-float of cat. _300)

3

Sarcocystis camelocanis sporocyst in a fecal - float of dog- 2000

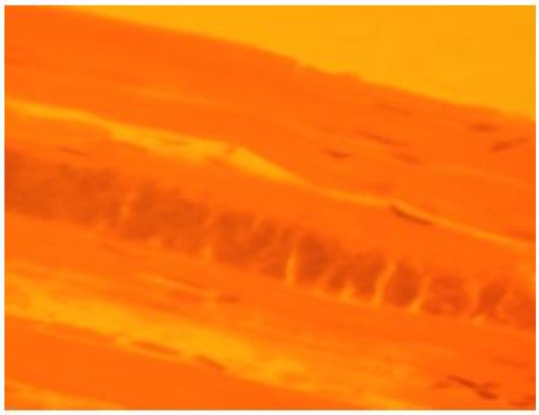
4

Sarcocystis cameli sporocyst in a fecal float of dog 2000.



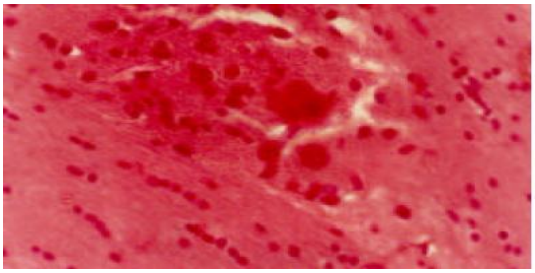
5

Sarcocystis cyst with thick striated outer and layers
(H&E)- 400



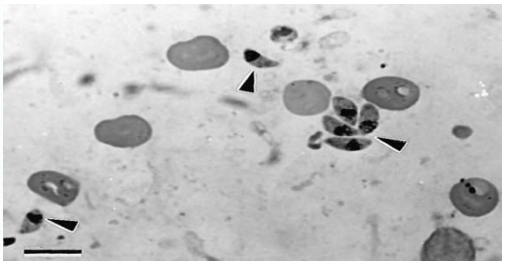
6

Sarcocystis cyst with thin wall of two smooth inner layer (H&E)- 400



7

Toxoplasma gondii tissue cyst in a section of camel brain. (arrowheads) in (H&E). _400



8

Toxoplasma gondii tachyzoites smear. Mouse peritoneum. Giemsa stain. _750

References

Abbas,B.Elzubeir,A.E.A.andYassin,T.M.(1987). Survey for certain zoonotic diseases in camels in Sudan Rev.Elev.Med.Vet.Pays.Trop. 40,231-233

Abdel Gaffar ,F.R.,Entzeroth,S.,Cobotar,E.B.and Scholty Seck,E.(1979). Tropenmed.Parasitol. 30,434-438.

Bronstein,S.and,Musa,B.E..(1987). Prevalence of antibodies to some viral pathogens, Brucella abortus and Toxoplasma gondii in serum from camels (Camelus dromedarius) in Sudan.J.of Veterinary Medicine 34,264-370

Elamin ,E.A.,Elias,S.,Daugschies, A.,And Rommel,M.(1992).).Prevalence of Toxoplasma gondii antibodies in pastoral camels (Camelus dromedarius) in the Butana plains, mid- Eastern Sudan. Vet .Parasitol. ,43, 171-175.

ElBadawi,K.S.,Machael,S.A.AndMorsy,T.A.(1984),J.Egy.Soc.Parasitol.,14 ,289-293.

El Din ,E.A.Z.,El Khawad,S.E.and Kheir, H.S.M.,1985,Rev.E lev.Med.Vet. Pays.Trop.,38,247-249.

Ginawi,M.A.andShommein,A.M.,1977,SudanJ.Vet.Sci.Anim.Husb,18, 92-97.

Dubey, J. P. (1978). Life cycle of Isopora ohioensis in dogs. Parasitology 77, 1–11

Dubey, J. P. (1979). Life cycle of Isospora rivolta (Grassi,1879) in cats and mice. Journal of Protozoology 26,433–443

.Dubey, J. P. & Beattie, C. P. (1988). *Toxoplasmosis of animals*. Boca Raton, FL: CRC Press.

Dubey, J. P. and Frenkel, J. K. (1972). Extra-intestinal stages of Isospora felis and I. rivolta (Protozoa:Eimeriidae)in cats. Journal of Protozoology 19, 89–92.

Dubey, J. P. & Frenkel, J. K. (1972). Cyst-induced toxoplasmosis in cats. *Journal of Protozoology*,**19**,155–77.

Dubey J.P,Lindsay D.S.1996 . A review on Neospora caninum and neosporosis. Veterinary Parasitology,67:1-59.

Dubey, J. P., Speer, C. A. and Fayer, R. (1989). Sarcocystosis of Animals and Man. CRC Press, Boca Raton, FL,USA.

Dubey, J. P., Schares, G. and Ortega-Mora, L. M.(2007). Epidemology and control of neosporosis and Neospora caninum. Clinical Microbiology Reviews 20,323–367.

Dubey, J. P., Barr, B. C., Barta, J. R., Bjerka˚ S, I.,Bjo¨rkman, C., Blagburn, B. L., Bowman, D. D.,Buxton, D., Ellis, J. T., Gottstein, B., Hemphill, A.,Hill, D. E., Howe, D. K., Jenkins, M. C., Kobayashi,Y., Koudela, B., Marsh, A. E., Mattsson, J. G.,McAllister, M. M., Modry´ , D., Omata, Y.,Sibley, L. D., Speer, C. A., Trees, A. J., Uggla, A.,Upton, S. J., Williams, D. J. L. and Lindsay, D. S.(2002). Redescription of Neospora caninum and its

differentiation from related coccidia. International Journal for Parasitology 32, 929–946.

Frenkel J.K. 1977 . Besnoitia wallacei of cats and rodents : with reclassification of other cyst forming coccidian.Parasitology63:611-628

Hilali,M.andMohamed,H.A.(1980) Tropenmed.Parasitol.31,213-214.

Khalil M.R. 2004. Epidemiolgical studies of toxoplasmosis in Khartoum State.MV Sc. Thesis, University of Khrtoum.

M**anal Y.Ishag ,1996**. Studies on tissue cyst forming coccidia from the one humped camel (Camelus dromedarius) in the Sudan . M.Sc. Thesis , University of Khartoum.

Manal Y.Ishag, El amin I.A. and Osman A.Y . 2000 Coccidian oocyst and sporocyst isolated from dogs (*Canis familiaris*) fed camel (*Camelies dromadaries*) meat. The Sudan J. of Veterinary Research, 16: 11.

Manal Y.Ishag, El amin I.A. and Osman A.Y . 2001 Camel expermintally infected with *Sarcocystis (Camelis dromadaries).* The Sudan J. of Vetrinary Research.17: 27-33 .

Manal Y.Ishag, El amin I.A. and Osman A.Y. 2001 . Sudanese camel (*Camelus dromadarius*) as a host for *Toxoplasma gondii, Cystoisospora felis and Cystoisospora rivolta*. The Sudan J. of Veterinary Research and Husbandry, 40 (1, 2): 75-8

Manal Y.I., Majid A.M. and Magzoub E. 2005 Seroprevalence of *Toxoplasma gondii* antibodies in camels (*Camelus dromedarius*) in Sudan. Al Buhuth, The Sudan J. of Scientific Research, 9 (1):94-102

Manal Y.I., Majid A.M., Magzoub E. 2005. Effects of *Sarcocystis cameli* on expermintally infected camels. AlBuhuth, The Sudan J. of Scientific Research, 9 (1): 70-80

Manal Y.I., Magzoub E. and Majid A.M . 2006. Detection of *Toxoplasma gondii* tachyzoites in milk of expermintally infected lactating she-camel. J. of Animal and Veterinary Advances, 5(6): 456-458.

Manal Y.I., Majid A.M. and magzoub E. 2006 . Congenital toxoplasmosis in camels. 11th International Congress of Parasitology-ICOPA XI, Glasgow. P.447-452 (Scottland, United Kingdom) 6-11 August 2006

Manal Y.I., Majid A.M., Magzoub E. 2006 . Isolation of a new *Sarcocystis* species from Sudanese camels (Camelus dromadarius). International J. Tropical Medicine, 1 (4): 167-169

Mana lY.I. and Majid A.M. 2009 . Association of diarrhea with congenital toxoplasmosis in calf-camels (Camelus dromedarius).Sudan Academy of Sciences Journal, 3(1):1-6.

McAllister, M. M., Dubey, J. P., Lindsay, D. S., Jolley,W. R., Wills, R. A. and McGuire, A. M. (1998). Dogs are definitive hosts of Neospora caninum. International Journal for Parasitology 28, 1473–1478.

Warrag, M. and Hussein, H.S. (1983) . J.Parasitol. 69 (5), 926-929.