PREVALENCE OF BLOOD AND INTERNAL PARASITES IN SHEEP TO BE SLAUGHTERED IN KHARTOUM STATE
Sudan

By
ABDEL BASIT AHMED EDREES MOHEMED
(B. V. M. 2003, University of Khartoum)

Supervisor
DR. KHITMA HASSAN ELMALIK
(B. V. Sc., M. V. Sc., Ph. D.)

A Thesis Submitted to the University of Khartoum in Partial Fulfillment of the Degree of Master of Tropical Animal Health,
(M. T. A. H.)

Department of Preventive Medicine and Veterinary Public Health,
Faculty of Veterinary Medicine, University of Khartoum

December 2006
To:

My parents and my sister

Soul of my grand mother

Soul of my grand father

My brothers... and my friends...
Thanks first and last to Allah, who gave me the health, strength and makes this work possible. My appreciations and best thanks to:

- Dr. Khitma Hassan El Malik for her keen supervision and valuable guidance.
- Dr. Atif Al Amin A. Gadir for data analysis and unlimited help.
- The staff of the Department of Preventive Medicine and Veterinary Public Health, especially Mr. Ahmed A. Wahid for technical help and Mr. Babo Mahmoud for his efforts during samples collection.
- My colleagues, especially Dr. Hatim A. Altahir for providing transport during different stages of the study, also my best thanks for Dr. Mohammed A. Elmoneim, Dr. Mohammed Siddig Al Arabi, Dr. Mohammed El Wasik and Dr. Ibrahim M. Elhassan for helping me in samples collection.
- My brother Abd-El Elah Ahmed for the unlimited help and continuous support.
Abstract

This study was conducted on sheep brought from different states of Sudan (Kordofan, White Nile, Darfour and Algadarif) to Khartoum State to be slaughtered for local consumption and export. The study conducted in three slaughter houses in the three towns of the state in the period between April to June 2006, to investigate the prevalence of blood and internal parasites and to assess the relationship between the occurrence of these parasites and factors of, body temperature, origin, breed, age and sex. A total of 150 samples were examined during this study.

The results showed that, the prevalence of blood parasites was 15.3%, *Theileria spp.* showed the highest prevalence rate (14.7%), only one *Babesia spp.* parasite was detected with 0.6% prevalence rate. The results showed high prevalence rate of internal parasites (27.3%), *Eimeria spp, Hemoncus, Strongyloides, Monezia* and *Fachiola spp.* eggs were detected in fecal examinations with prevalence rates 12%, 8%, 2.6%, 4% and 0.7% respectively. Statistical analysis for results was done and showed no correlation between prevalence of blood and internal parasites with origin, breed, sex and ages of sheep. A strong relationship was detected between prevalence of blood parasites and body temperature of sheep.
الخلاصة

جرىت هذه الدراسة على مجموعات الضان القادمة إلى الخرطوم من مختلف ولايات السودان بغرض الربح للاستهلاك المحلي والتصدير. وقد طالت الدراسة عدد 150 رأس من الضان القادمة من ولايات كردفان، دارفور، النيل الابيض والقضارف تجمعت في ثلاثة من مسالخ الولاية في مدنها المختلفة. هدفت هذه الدراسة إلى تقسيم معدل الاصابة بطفيليات الدم والطفيليات الداخلية وعلاقة بعض العوامل مثل درجة حرارة جسم الحيوان بالإصابة بالطفليات، وكذلك تأثير سلالة وعمر وجنسي الحيوان على القابلية للإصابة بالطفليات.

أظهرت النتائج أن معدل حدوث الاصابة بطفيليات الدم قد كان 15.3% بمعدل 14.7% بالنسبة لطائر التيليريا ومعدل 0.6% بالنسبة لطائر البابيزيا.

الدراسة أوضحت معدل عاليا للإصابة بالطفليات الداخلية بلغت 27.3% بواقع نسب بلغت 12% - 8% - 6% - 4% و 0.7% لكل من الطفيليات الأثية على التوالي الكوكسية، هيمونكس، سترونفلس، مونيزيا والفاشيولا 0.

اشتهرت نتائج التحليل الاحصائي للمعلومات المدخلة إلى عدم وجود علاقة بين الطفليات المذكورة وسلالة، جنس، عمر و/or الحيوان، لكنها اشتملت إلى علاقة قوية بين طفليات الدم ودرجة حرارة جسم الحيوان 0.
INTRODUCTION

Sudan is rich in its animal’s resources. The country has an animal population estimated at 40.468 million cattle, 49.797 million sheep, 42.526 million goats, 3.908 million camels, 37 million poultry and 110 thousands ton fishers (MARF 2005). In Sudan there are several breeds of sheep, such as, Kabashi, Hamari, Shukri and Zagawi in north and western Sudan, Watish in central Sudan and Nilotic sheep in southern Sudan. Sudanese sheep comprise 31% of the total population of sheep in the Arab region (AOAD, 1998) and they are raised in different parts of the country for their meat, milk, and hides. Exports of live sheep and mutton contribute significantly to the national income from foreign exchange which was estimated to be US$ 109 million annually in 1998. Sheep also have religion and social importance. They play an important role in public health because they could be a source for several zoonotic diseases transmuted to man, such as, Brucellosis and T.B.

Sheep production in Sudan faces many problems including infectious diseases caused by bacterial, viral, and parasitic agents. Bacterial and viral diseases have almost been brought under control either by drug therapy or vaccination. Parasitic diseases, however, have largely been neglected primarily because they do not often cause acute faecal disease. Blood parasites are living organisms which inhabit on blood and feed on its constituents or nutrients. The blood parasites are difficult to control due to the resistance of some parasites to drugs, and there is no successful vaccine against most of blood parasites due to several factors such as antigenic variation and difficulties in propagation of these organisms in artificial media.

The infection with blood parasites can be suspected from general symptoms of diseases such as decrease in production, emaciation, loss of
appetite and jaundice. Animals also take time to reach the peak of production after recovery.

Sheep may be affected by *Trypanosoma. vicax*, *Trypanosoma.congolnse* and *Trypanosoma.dimorphon* that cause Trypansomosis, or *Theileria. lestoquadri* which cause malignant ovine Theileriosis, *Babesia.motasi*, *Babesia.ovi* that cause ovine babesiosis. Prelarval stages for several nematodes, the microfilaria, which appear in several diseases affect sheep such as Elaeophorhiasis (filarial dermatitis in sheep), Thelasiasis (eye worm), Neurofilariasis, Cerebrospinal nematodiasis (lumber paralysis).

Helminthes parasites are known to prevail in this country (Gagoad and Eisa (1968), Eisa and Ebrahim (1970), Elbadawi et al (1978) and Atta Elmannan (1983). Helminthes of the gastrointestinal tract are major cause of reduced productivity in ruminants throughout the world (Holmes 1987). In general the effect of parasitic diseases on livestock include mortality losses, condemnation of meat, weight loss, depreciation of animal's products and reduced resistance to other diseases as well as expenditure on drugs. Also they cause anemia, Economic effects the damaged of the skin due to ticks and flies bites, costs of treatment, prevention and control of parasites and vectors.

Therefore the objectives of this study are:

1- To detect blood and internal parasites of sheep brought to Khartoum state in ante-mortem examination as a reflection of the common parasitic infections in the production areas.

2- To examine the effect of geographic origin of sheep in occurrence of parasitic infections.

3- To detect the prevalence of parasitic infections in different age groups.

4- To suggest a feasible strategy for control of parasitic infestation in sheep herds.
1.1 Sheep Breeds and Their Distribution in Sudan:

The estimated Sudanese national sheep flock is 49.797 million head (MARF, 2005). Sudan sheep are conventionally classified on the basis of morphology and distribution into four main groups: Sudan Desert, Sudan Nilotic, Sudan Arid Upland and Sudan Equatorial Upland (Mcleory, 1961; Wilson and Clarke, 1975). Fused ecotypes from non-systematic crossbreeding at the boundaries of the ecozones have also been recognized.

More than 65% of the sheep in Sudan are of the Sudan Desert type (*Ovis aries*) (Sulieman *et al*., 1990), which is believed to be a descendant of sheep of Egyptian origin (*Ovis longipes*). They are distributed north of latitude 18N, extending eastward into Eritrea and westward into Chad (Wilson, 1991) and are raised under pastoral system in the eastern and western regions of the country. Sudan Desert sheep are further classified into tribal subtypes, e.g. Hamari, Kabashi, Shenbali in North and West Kordofan States (Mukhtar, 1985), Shugor, Dubasi and Watish in the Central States (Sulieman *et al*., 1990) and Bourug in the Butana area of eastern Sudan.

In recent years, the use of Sudan Desert sheep as an export commodity has increased. In 1991/92, it contributed about $60 million to the national foreign exchange earnings at an annual off take rate of 600,000 head (LMC, 1992).
1.2 Sheep Meat Production
Sheep in Sudan play important role in production of meat for local consumption and export to numerous countries, a total of 76,728,000 head of sheep were slaughtered in period (2000 to 2004), statistical information on Tables (1-1), (1-2) and (1-3) (MARF, 2005).
Table (1-1) Slaughter sheep and meat production for local consumption

2000-2004

<table>
<thead>
<tr>
<th>year</th>
<th>No of slaughter sheep (000) head</th>
<th>Local consumption (000) ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>12545</td>
<td>138</td>
</tr>
<tr>
<td>2001</td>
<td>12909</td>
<td>142</td>
</tr>
<tr>
<td>2002</td>
<td>14041</td>
<td>154</td>
</tr>
<tr>
<td>2003</td>
<td>18495</td>
<td>222</td>
</tr>
<tr>
<td>2004</td>
<td>18738</td>
<td>225</td>
</tr>
<tr>
<td>Total</td>
<td>76728</td>
<td>881</td>
</tr>
</tbody>
</table>

Table (1-2) Estimation of sheep meat production for local consumption and export (000) T 2000-2004

<table>
<thead>
<tr>
<th>year</th>
<th>for export</th>
<th>Local cons.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>120</td>
<td>138</td>
<td>258</td>
</tr>
<tr>
<td>2001</td>
<td>120</td>
<td>142</td>
<td>262</td>
</tr>
<tr>
<td>2002</td>
<td>120</td>
<td>154</td>
<td>274</td>
</tr>
<tr>
<td>2003</td>
<td>60</td>
<td>222</td>
<td>282</td>
</tr>
<tr>
<td>2004</td>
<td>60</td>
<td>225</td>
<td>285</td>
</tr>
<tr>
<td>Total</td>
<td>480</td>
<td>881</td>
<td>1361</td>
</tr>
</tbody>
</table>
Table (1-3) Export of sheep meat (ton) 2000-2004

<table>
<thead>
<tr>
<th>year</th>
<th>meat production</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>6157.8</td>
</tr>
<tr>
<td>2001</td>
<td>4855.2</td>
</tr>
<tr>
<td>2002</td>
<td>7113.8</td>
</tr>
<tr>
<td>2003</td>
<td>7837.11</td>
</tr>
<tr>
<td>2004</td>
<td>5570.9</td>
</tr>
<tr>
<td>Total</td>
<td>31534.81</td>
</tr>
</tbody>
</table>
1.3 Parasitic diseases of sheep

1.3.1 Sheep Blood Parasites

1.3.1.1 Trypanosomosis:

Until recently Trypanosomosis in sheep and goats was not ranked as an important disease. Kramer (1966) reported that the disease in Nigeria was of little importance in these hosts, Stephen (1970) and Finelle (1973) stated that sheep and goats are seldom infected with Trypanosomosis under natural conditions. Later studies indicated that not only are these animals naturally infected by this disease, but also high mortality can occur (Griffin and Allonby, 1979). Evidence was obtained from experimental infection that sheep and goats act as reservoir and may be important in the transmission of Trypanosomosis (Khasanov and Ivanitskaya, 1974 and Mahmoud and Elmalik, 1978).

Thousands of sheep and goats were examined since 1942 in the upper Nile province Sudan but only *T. vivax* was identified (Karib, 1961).

In Sudan, Boid et al. (1981) suggested the role of sheep and goats in Kassala province as reservoir after he found antibodies against *Trypanosoma. evansi* circling on there blood.

Osaer et al. (1999) stated that trypanosomosis seem to affect sheep and goat health and production. Masiga et al. (2002) showed that mall ruminants are susceptible to trypanosomosis and revealed anaemia and reduction in body weight.

Infected animals usually look healthy and normal infections were often chronic or sub clinical and were rarely detected because of low parasitaemia and trypanosoma concentration, on the other hand Kalu et al. (1986) observed that.
1.3.1.2 Blood parasites transmitted by ticks:

Ticks are regarded as an important external parasites in animals' especially in tropical and sub tropical zones where they transmit most of the serious diseases, among which the majority are blood parasites and *Reckittsea*.

1.3.1.2.1 Sheep Theileriosis:

Theileriosis are tick borne protozoan diseases caused by *Theileria* spp in cattle, sheep, and goats as well as in wild and captive ungulates (Radostits *et al.*, 2000). The diseases are characterized by fever and lymphoproliferative disorders, which may be associated with leucopenia and/or anemia (Radostits *et al.*, 2000).

The important pathogen of sheep and goats is *Theileria hirici* (synonym *Theileria lestoquardi*), the cause of malignant ovine theileriosis (Radostits *et al.*, 2000). The disease is enzootic from North Africa through the Middle East to India (Radostits *et al.*, 2000). *Theileria hirici* cause disease in sheep similar to *Theileria annulata* in cattle (Radostits *et al.*, 2000). In a recent Sudan outbreak involving eight flocks, 22% of the sheep affected and all affected sheep were died within 3-6 days (Radostits *et al.*, 2000). Anemia, jaundice, and enlargement of lymph nodes are characteristic, and both piroplasms and schizonts can be demonstrated in smears of blood and tissues respectively. An indirect fluorescent antibody test is available (Radostits *et al.*, 2000). Parvaquone and buparvaquone may be used to treat early cases (Radostits *et al.*, 2000). Benign ovine theileriosis is caused either by *T. ovis* or *T. separate* in Africa (Radostits *et al.* 2000).
1.3.1.2.2 Sheep Babesiosis:

Babesiosis are a group of tick born diseases caused by several species of protozoa of the genus *Babesia*. These organisms are capable of infecting all species of domestic animals, and also found in some wild animals, which serve as reservoir of infection (Losos, 1986a). During infection with babesia, the release of pharmacologically active substance and destruction of erythrocytes play a major role in the pathogenesis of the disease. However, the proportionate role of each varies with the individual species of babesia (Soulsby, 1982). Anaemia is associated with the emergence of the parasites from red cells. Often, however, erythrocytes loss is attributed to the mechanical rupture of red cells by the parasites although there have been no detailed studies of this in domestic animals (Mohoney, 1977).

*Babesia ovis* in sheep and goats is distributed throughout tropical and subtropical areas. Also in southern Europe and the former Soviet Union (Soulsby, 1982). Its effect is less severe than other babesia species. Although an acute phase characterized by fever, jaundice, haemoglobinuria and anaemia may be seen, and in the chronic form of the disease about 1% of the erythrocytes is infected (Soulsby, 1982). Comprehensive reviews of the literature on Babesia and its infection had been published by many authors, among them, Riek (1968), Mahoney (1977) and Levine (1988).

Piroplasmosis in the Sudan was early reported in the beginning of the past century, Babesiosis was reported in 1905 but little research was done by (Hoogstral, 1956), FAO (1983), Abdoun (1984), Hashim (1984), Mohammed and Yagoub (1990).
1.3.1.2.3 Anaplasmosis
Anaplasmosis is an acute or sub acute febrile disease of wild and domestic ungulates. It caused by the Rickettsia, *Anaplasma marginale*, *Anaplasma Centrale* and *Anaplasma ovis*, the former being more pathogenic. It is characterized by progressive anaemia and occasionally icterus (Losos, 1986b). Twenty species of tick have been shown to transmit *Anaplasma*. Transovarial transmission occurs and insects (blood sucking flies e.g. deer flies, stable flies) play a significant role in mechanical transmission (Soulsby, 1982). Anaplasmosis causes subclinical forms of the disease in sheep and goats but could be serious to exotic cattle. In more chronic cases there is a sever anaemia and recovery is slow. Control by vaccination has been attempted by several means for many years. (Soulsby, 1982).

1.3.1.3 Filarial worms
These worms inhabit connective tissues and blood vessels, on the serosae and in many other regions (Dunn, 1978).
The adult worms of genus *Setaria* are commonly found in the peritoneal cavity of the final host, (Dunn, 1978). The microfilaria produced by female circulate in the blood are unsheathed and measure 190 um 256 um. *Setaria* may incriminate in the etiology of cerebrospinal filariosis in aberrant infections (Jones *et al.*, 1997 and Mahmoud *et al.*, 2004). Its intermediate hosts in the tropical areas are mosquitoes of many genera (Anopheles, Ades, Culex, etc.) (Soulsby, 1982).

1.3.2 The internal parasites that affect sheep
In most sheep-raising areas, internal parasites (i.e. worms) are usually the primary disease affecting sheep and lambs (Susan 2006). Sheep are more susceptible to internal parasites than most other types of farm livestock.
Their small fecal pellets disintegrate very easily thus releasing the worm larvae onto pastures (Susan 2006). They graze close to the soil surface and to their feces. They are slow to acquire immunity. It takes 10 to 12 months for most lambs to develop immunity to parasites. Sheep also suffer a loss of immunity at the time of lambing, which does not restore itself until approximately four weeks after lambing (Susan 2006). Heavy stocking rates and insufficient pasture rest periods further contribute to the incidence of parasitic disease in sheep and lambs. Internal parasites tend to be much less of a problem under range-type conditions where sheep do not graze the same pasture twice in the same grazing season. They are also less of a problem in arid regions, because parasites require moisture for their development (Susan 2006). In the past, sheep producers relied heavily on anti-parasitic drugs, called "anthelmintics" to control internal parasites in their flocks. But the long-time use and in some cases misuse of these drugs has resulted in parasites that have become increasingly resistant to anthelmintics. Drug resistance has been documented in all three drug families and is most commonly reported with ivermectin and the benzimidazoles. In the U.S., few anthelmintics are FDA-approved for use in sheep and lambs, and no new drugs are likely to be developed. As a result, producers must develop more integrated programs for controlling parasites, which do not rely exclusively on drug therapy (Susan, 2006).
<table>
<thead>
<tr>
<th>Genus and species</th>
<th>Common name</th>
<th>Site</th>
<th>Life cycle</th>
<th>Ideal Conditions for Development</th>
<th>Clinical signs</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Haemonchus contortis</em></td>
<td>Barberpole worm</td>
<td>Abomasum</td>
<td>Direct</td>
<td>18 to 21 days, warm, moist, summer rainfall</td>
<td>Blood loss (Anemia), Edema (&quot;Bottle Jaw&quot;), Weakness Wool breaks, Sudden death</td>
</tr>
<tr>
<td></td>
<td>Wire worm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Ostertagia circumcincta</em></td>
<td>Medium or brown stomach worm</td>
<td>Abomasum</td>
<td>Direct</td>
<td>20 days, cool, moist</td>
<td>Production loss, Lack of appetite Diarrhea, Weight loss, Decreased wool production.</td>
</tr>
<tr>
<td><em>Trichostrongylus</em></td>
<td>Bankrupt worm</td>
<td>Abomasum</td>
<td>Direct</td>
<td>&lt; 21 days, warm, moist</td>
<td>Black scours, Reduced appetite Production loss, Ocasional death</td>
</tr>
<tr>
<td></td>
<td>Hair worm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small intestine</td>
<td></td>
<td>Direct</td>
<td>7-9 days, warm, moist</td>
<td>Weight loss, Diarrhea, Inflammation between toes</td>
</tr>
<tr>
<td><em>Strongyloides papillosus</em></td>
<td>Common threadworm</td>
<td>Small intestine</td>
<td>Direct</td>
<td>20 days, cool, wet, winter rainfall</td>
<td>Loss of appetite Diarrhea Weight loss Decreased wool growth</td>
</tr>
<tr>
<td><em>Coopera spp.</em></td>
<td>small intestinal worm</td>
<td>Small intestine</td>
<td>Direct</td>
<td>20 days, cool, wet</td>
<td>Usually sub-clincial Diarrhea, loss of appetite, weight loss</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Nematodirus spp.</em></td>
<td>threadneck worm</td>
<td>Small intestine</td>
<td>Direct</td>
<td>20 days, cool, wet</td>
<td>Usually sub-clincial Diarrhea, loss of appetite, weight loss</td>
</tr>
<tr>
<td><em>Dictyocaulus filaria</em></td>
<td>lungworm</td>
<td>Trachea and bronchi</td>
<td>Direct</td>
<td>5 weeks, cool, wet</td>
<td>Usually no signs of infection. Coughing, fluid in lungs if disease is severe. Pneumonia</td>
</tr>
<tr>
<td><em>Muellerius capillaris</em></td>
<td>hair lungworm</td>
<td></td>
<td>Indirect (snails, slugs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Moniezia spp.</em></td>
<td>tapeworm</td>
<td>Small intestine</td>
<td>Indirect (pasture mites)</td>
<td>6 weeks, Wet</td>
<td>Heavy infestations may result in unthriftiness and GI disturbances</td>
</tr>
<tr>
<td>Species</td>
<td>Stage</td>
<td>Location</td>
<td>Pathway</td>
<td>Incubation</td>
<td>Climate</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------</td>
<td>------------</td>
<td>-------------</td>
<td>------------</td>
<td>---------</td>
</tr>
<tr>
<td>Eimeria spp.</td>
<td>coccidia</td>
<td>Small intestine</td>
<td>Direct</td>
<td>&lt; 21 days</td>
<td>cool, wet</td>
</tr>
<tr>
<td>Trichuris ovis</td>
<td>whipworm</td>
<td>Caecum</td>
<td>Direct</td>
<td>6-12 weeks</td>
<td>Dry</td>
</tr>
<tr>
<td>Bunostomum phlebotomum</td>
<td>hookworm</td>
<td>Small intestine</td>
<td>Direct</td>
<td>1-2 months</td>
<td>warm, most</td>
</tr>
<tr>
<td>Oesophagostomum</td>
<td>nodule worm</td>
<td>Large intestine</td>
<td>Direct</td>
<td>5 weeks</td>
<td>cool, wet</td>
</tr>
<tr>
<td>Paralaphostrongylus tenius</td>
<td>meningeal worm</td>
<td>central nervous system</td>
<td>Indirect (snails, slugs)</td>
<td>82-91 days</td>
<td>cool, wet</td>
</tr>
<tr>
<td>Fasciola hepatica</td>
<td>liver fluke</td>
<td>Liver</td>
<td>Indirect (snails, slugs)</td>
<td>8-12 weeks</td>
<td>Wet</td>
</tr>
</tbody>
</table>
1.3.2.1 Prevalence of Gastrointestinal Helminthes of Sheep in Africa

In Egypt Shawakt et al (1994) examined 250 abomasums of sheep slaughtered in Cairo abattoir; the examination revealed that 43.7% of these were harboring single or mixed nematode infections. Trichostrongylus spp, Haemonchus contortus and Oestertagia spp, were identified in the study with prevalence rate of 28.9, 22.2, and 17.18% respectively. Abd-Rabo et al (1993) examined gastrointestinal tracts of sheep from Kafr-Elshih governorate, Egypt; He encountered 9 species of nematodes (Trichostrongylus axei, Strongyloides papilosus, Haemoncus contortus, Ostertagia trifurcta, Parabonema skrjabini, Nematodirus spathiger, Trichuris ovis, Chabertia ovina and Oesophagostomum columbianum). The frequency of nematode infection in the abomasums, small and large intestine were 21.67, 21.67 and 36.67 respectively.

El Azazy (1990) examined 96 abomasums from sheep and goats at Zagazig abattoir, Sharkia province, in 1986 and 1987 he observed that adult Trichostrongylus axei was the most numerous followed by adult Haemoncus contortus.

In Nigeria; Fakae and Chiejina (1993) conducted a survey on traditionally reared west African Dwarf sheep and goats in the eastern Nigeria for over 12 months period during 1987 to 1988. They reported that the most prevalent nematodes were Haemoncus contortus and Trichostrongylus colubriformis and which usually occurred together in all nematode infected animals. Their combined prevalence rates ranged from 90% to 100%. On the other hand, Cooperia curticei and Oesophagostomum columbianum were present in relatively small numbers.

Earlier Fakae (1990) studied the epidemiology of helminthes infections in west African Dwarf sheep and goats in the savanna area of eastern Nigeria for 12 months, the infections observed involved Haemoncus
contortus, Trichostrongylus spp., Taenia hydatigena metacestodes, O. columbianum, Strongyloides spp., Cooperia spp. And Gaigeria pachyscelis with a prevalence rates of 87.1, 63.8, 30.2, 22.4, 18.8, 17.2, and 6% respectively. Anene et al. (1994) carried out a survey of gastrointestinal parasites of 948 small ruminants in south eastern Nigeria in the dry and rainy seasons; they reported that Strongylys (mainly Haemonchus) was the most prevalent gastrointestinal parasites in sheep. The prevalence rate reported in the dry season was 39.8% while that of the wet season was 63.7%. Onyali et al., (1989) studied patent infections of Strongyloides papillosus in lambs under one week of age and it was suggested that either the short generation interval or prenatal infection was the cause. Worm egg counts taken at monthly intervals indicated ranges from 100-1000 eggs per gram (e.p.g) of feces.

In Ethiopia Bekele et al., (1992) conducted post-mortem examination on 122 gastrointestinal tracts of sheep. In their study, they reported rates ranging from 66.7% to 100% for Dictyocoulus filarial and 64% to 100% for Trichostrongylus colubriformis, low prevalence rates for Trichostrongylus axe, Haemoncus contortus, Oesophagostomum columbianum, Bunostomum. Trigonocephalum and Trichuris. Srjabini were reported. Njau et al., (1990) also investigated the prevalence rate of gastrointestinal parasites of sheep in that country, the parasites found were Coccidia, Haemoncus contortus, Trichostrongylus colubriformis, Trichostrongylus axe, Ostertagia spp., Trichuris. Ovis, Chabertia Ovina and Faschiola hepatica. Lemma (1998) found a seasonal pattern of Trichuris ovis in sheep, and showed that the seasonal variations were due to humidity (rain).

In Mauritania, Jacauiet et al., (1995) performed 647 faecal eggs counts and 53 necropsies on sheep and goats originating from three sites of the Sahelian region. The examination revealed that Haemoncus contortus,
Oesophagostomum columbianum and Stilesia globipunctata were the most prevalence species.

In Kenya; Ndarathi et al., (1989) examined a total of 1412 animals from three Masai groups for parasites, their study showed that between 60% to 70% of the sheep and goats were infected with gastrointestinal parasites, and they stated that Strongylosis was the most prevalent gastrointestinal infection allowed by coccidian, while prevalence of other parasites was less than 6%. In another study Ndarathi (1992) reported that prevalence of Haemoncus contortus, Trichostrongylus spp., and Oesophagostomum spp. were 91.1, 6.4, and 1.7% respectively.

Pandey (1990) examined 304 abomasums of sheep grazing on natural pasture in Highveld, Zimbabwe; Haemoncus contortus was found in 70% the organs examined. He observed that the worm burden increased during the rainy season and was followed by a decline with low worm load throughout the dry season.

In Zaire, Chartier et al., (1990) examined carcasses of sheep, and reported that the most frequent species were Haemoncus contortus, Trichostrongylus colubriformis and Oesophagostomum columbianum with prevalence rates of 70.1, 78.6, and 100% respectively.

1.3.2.2 Prevalence of Gastrointestinal Helminthes of Sheep in Sudan

In kordofan, Kassala, Darfur and Blue Nile provinces Gagoad and Eisa (1968) examined 322 abomasums of sheep, their study showed that 80% of the sheep harbored Haemobcus contortus. They reported that the incidence rate in kordofan, Kassala, Darfur and Blue Nile was 83, 73.5, and 75% respectively. Eisa and Ebrahim (1970) examined gastrointestinal tracts of sheep obtained from Elobied, they reported the occurrence of Haemoncus contortus, Trichostrongylus colubriformis, Strongyloides papillosus, Oesophagostomum columbianum, Chabertia ovina, Cooperia.
pectinata, Trichuris ovis and Monezia expansa. Haemoncus contortus was found to be the most prevalent species.

Elbadawi et al., (1976) conducted a study of helminthes parasites in 140 sheep carcasses in the southern region of the country. They reported the dominance of Paramphistomum spp. Followed by Cysticercus tenuicollis, Faschiola gigantica and Schistosoma bovis. Elgezuli et al.,(1978) carried out a survey of helminthes parasites of cattle, sheep, goats and camels at Kassala province, they examined 341 large intestines of goats and 66 of sheep. Their study showed that 11.7% of goats harbored Skrjabinem ovis, while none of the sheep harbored this parasite.

Elbadawi et al., (1978) studied the incidence of helminthes parasites of sheep slaughtered in the western provinces. A total of 1397 carcasses were examined, they encountered eight genera of helminthes parasites vise tow genera of trematodes (Paramphistomum spp. and shistosoma ovis), three genera of cestodes and larval cestodes (Avitellina spp. Monezia expansa and Hydrated cyst), and three genera of nematodes (Trichuris ovis, Oesophagostomum colombianum and Haemoncus contortus)

The highest incidence was for Haemoncus contortus, Schistosoma bovis and Oesophagostomum colombianum with a rate of 45.5, 44.5 and 39.5 respectively. The incidence of Trichuris ovis, hydatid cyst, Monezia expansa and Avitellina spp. was 20, 12, 9 and 3% respectively. They showed that the maximum combination of genera found in one animal was four in their checklist of helminthes in Sudan. Eisa et al., (1979) reported helminthes in sheep in the Sudan during the period 1902-1975. They reported 20 genera of helminthes parasites 5 genera of trematodes namely (Faschiola gigantica, Schistosoma bovis, Paramphistomum spp. Dicrocoelium spp. and Cotylophoron cotylophorum), 6 genera of Cestodes (Avitellina spp., Monezia expansa, Monezia benedeni, Stilesia
hepatica, Cystecercus tenuiocollis, Hydatid cyst, Coenurus cerebralis, Coenurus serialis), and 9 genera of nematodes (Bunostomum spp., Chabertia ovina, Cooperia pectinata, Gaigeria pachyscelis, Haemoncus contortus, Trichuris ovis, Oesophagostomum columbianum, Strongyloides papillosus and Trichostrongylus axei).

Atta Elmannan (1983) investigated the gastrointestinal parasites of sheep and goats in Sennar district (central region) by means of microscopical and post mortem examination. He found eggs of 4 genera of parasites during faecal examination, this comprised Trichostrongylid spp., Monezia expansa, Strongyloides papillosus, and Trichuris spp. the incidence of parasites in sheep was 83.9%. where incidence of infection with one species was the highest (43.9%) and with four species was the lowest (3%), he revealed that Trichostrongylus axei was the dominant species during examination of gastrointestinal tracts.

Atta Elmannan et al., (1983) studied the prevalence of Oesophagostomum columbianum in sheep in Sennar district, they examined a total of 28 gastrointestinal tracts for adults worms. They showed that 21 were infected with a prevalence of 75%.

Ahmed and Elmalik (1997) investigated the prevalence of Nematodes in sheep brought to Khartoum from different localities of Sudan, four genera of Nematodes were identified from faecal culture, these include, H. contortus, Strongyloide papillosus, Oesophagostomum spp., and Trichostrongylus spp., with a prevalence rates of 56.3, 36.6, 3.7 and 3.4% respectively. The highest of infection was observed during the rainy season 85% compared with a rate of 35.6% during the winter.

Ghada (2000) studied the prevalence of gastrointestinal helminthes of sheep from central Kordofan and White Nile state. She examined 1005 faecal samples from sheep, she showed that presence of different helminthes eggs, which include, Trichostrongylus, Strongyloide
papillosus, *Trichuris spp.*, *Monezia expansa*, *Monezia benedeni* and *Paramphistomum spp.*, with a highest prevalence rates in rainy season.

1.4 Transmission

1.4.1. Transmission of blood parasites:

1.4.1.1 Cyclic transmission:

In this mode of transmission the parasites are capable to develop cyclically in side the vector.

Trypanosome in Africa are mainly transmitted by Glossina species (tsetse fly) in which trypanosome are capable to develop cyclically in the digestive tract of the fly. Different trypanosome species develop in different regions of the digestive tract of the fly, these are *Trypanosoma congoense*, *T. vivax*, *T. brucei*, *T.simiae*, *T. suis* (Hoare, 1972).

The piroplasms-infected erythrocytes are ingested by a clean tick (Larva and nymph) when it feeds and piroplasm released which differentiate into sexual stages in the gut of the tick (Schein, 1975). The parasite multiplies to schizont after inoculation of sporozoites with saliva of infected ticks into the vertebrate host and invades different leukocytes (Irvin *et al.*, 1982).

1.4.1.2 Mechanical transmission:

In this mode of mechanical transmission, the parasites are taken up with blood and survive for short time in the mouth part of insect (Hoare, 1970).

Tabanidae and other biting flies were incriminated for this type of transmission in area far from tsetse main belt and in the countries out side Africa. Hoare (1957) put forward hypothesis that *Trypanosoma vivax* had become established in Mauritius and the new world by adapting completely to mechanical transmission. He further argued that
Trypanosoma evansi originated from Trypanosoma brucei by similar adaptation to mechanical transmission. Domizio (1930) and Spena (1948) reported the occurrence of Trypanosoma vivax in Eritrea and central Ethiopia, which are tsetse free areas. They both considered tabanids and Stomoxid flies to be the vectors. Also Buxton (1955) mentioned that Tabanids and biting muscids are important vectors of trypanosomes in some tsetse free parts of Africa. Several authors wrote and conducted studies on the role of tabanids and other biting flies in epidemiology of Nagana and Surra. Roeder et al. (1984) described an incidence of acute Trypanosoma vivax infection in cattle in high lands of Ethiopia where the weather is too cold for tsetse survival. Outbreaks of Trypanosoma evensi in cattle and buffaloes in India were reported to increase with the increasing numbers of Tabanus spp. and Stomoxys spp. In Vietnam, Phung and Pham (1995) dissected biting flies and identified considerable rate of T. evesi infection in tabanids, Stomoxys calcitrans and Heamatebia exigua. Hussein et al. (1991) reported Atylotus spp. as vectors of Trypanosoma evensi in camels in Saudi Arabia. Desquesnes and Dia (2003) demonstrated the ability of one of the most common tabanids found in Africa, Atylotus agrestis, to transmit T. vivax mechanically to cattle.

1.4.2 Internal parasites transmission
1.4.2.1 Direct transmission
Nematode can be transmitted directly in case of pasture contamination by ingestion of free L3 (infective stage) such as Trichostrongyloid and Strongyloid, however infection sometimes can happen by larval penetration of the skin or by ingestion of the eggs containing a larva (Radostits et al., 2000).
1.4.2.2 Indirect transmission
In case of nematodes, the first two moults usually take place in an intermediate host and infection of the final host is either by ingestion of intermediate host or by inoculation of the L3, when the intermediate host such as blood sucking insect feeds (Radostits et al., 2000).
Trematodes are transmitted by the snails as intermediate host, the infective stage (cercaria, metacercaria) emerge from snail and swim to contaminate the pasture.
The typical life cycle of cestodes is indirect with one intermediate host.

1.5 Diagnosis
1.5.1 Diagnosis of sheep blood parasites:
1.5.1.1 Diagnosis of sheep Trypanosomosis:
Clinical diagnosis of individual animals is indicated (Uilenberg, 1998) but not confirmative (OIE, 1996).
Trypanosomoses can be diagnosed by direct parasitological, serological or molecular techniques.
1.5.1.1.1 Parasitological methods:
These methods include examination of fresh drop of blood under cover slip as a wet smear, stained thin and thick film. Thos are specific techniques but their sensitivity is relatively low, as parasitaemia is generally low and fluctuating. Therefore, negative results do not always mean that the animal is not infected. Negative test should be repeated before establishing final diagnosis (OIE, 1996). More sensitive parasitological method depends on the concentration of trypanosomes in the buffy coat by microhaematocrit centrifugation techniques (Woo, 1970). This technique is efficient and may detect as few as 5 trypanosomes/ml (Kalu et al., 1986).
The relative efficiency of these several methods of diagnosis may vary between trypanosomes species, the chance may be improved by used dark ground phase contrast and concentration techniques (Murray et al., 1977). Also in this method measuring packed cell volume is indication of the degree of anaemia (Woo, 1970; Murray et al., 1977; Brown et al., 1990; OIE, 1996).

1.5.1.1.2 Serological methods:
The antibodies detection by several techniques has been tried for diagnosis of trypanosomes. At the present the in direct fluorescence antibody test (IFAT) allows detection of species-specific antibodies (OIE, 1996), the method had been widely applied for diagnosis for bovine trypanosomosis in Africa (Luckins, 1992).
The enzyme linked immunosorbent assay (ELISA) has been used to detect infection in camels (Luckins, 1999), buffalo and cattle (Payne et al., 1991). Desquesnes et al., (1996) reported that Ag ELISA is an important tool for epidemiological surveys.

1.5.1.1.3 Molecular biology techniques:
The principle of the molecular tests is the demonstration of the occurrence of sequences of nucleotides, which are specific for trypanosome subgenus, species or even type or strain (Uilenberge, 1998). Polymerase chain reaction (PCR) is based on the use of an enzyme, DNA polymerase enzyme. The technique was used to be an efficient tool for estimation of the prevalence of African trypanosomosis (Solano et al., 1999).
1.5.1.2 Diagnosis of tick born diseases

1.5.1.2.1 Provisional diagnosis:
The simples' diagnostic method is case history, clinical signs, post-mortem findings and knowledge of disease and vector distribution (OIE, 2000), despite the fact that clinical picture of the disease is not pathognomic (Lossos, 1986a). The clinical signs include fever, enlargement of peripheral lymph nodes, difficult breathing, frothy nasal discharge (Boulter and Hall, 2000).
Diarrhoea, lacrimation, dullness, haemoglobinuria in case of babesiosis, recumbency and death may occur within two to three weeks post infection (Gill et al., 1977; Uilenberg, 1981). Post mortem findings include subcutaneous and pulmonary oedema, petichial hemorrhages on various organs.

1.5.1.2.2 Laboratory diagnosis:
By Geimsa stained blood or tissue smears in order to detect schizonts in lymph nodes and impression smears, while piroplasms appear in blood smears (Soulsby, 1982; Norval et al., 1992).

1.5.1.2.3 Serodiagnosis:
The most suitable and commonly used serum antibody assay has been the indirect fluorescence antibody test (IFAT) (Burridge 1971; Burridge and Kimber, 1972; Burridge et al., 1974; Goodeeris et al., 1982). The test has been widely used in epidemiological studies in different African countries including Sudan (FAO, 1983).
Recently the enzyme linked immunosorbant assay (ELISA) is widely applied in detecting circulating parasites-specific antibodies, antigens and immune complexes (Dolan, 1989). The test has many advantages compared with (IFAT).
1.5.1.2.4 Molecular techniques

Usage of molecular tools based on DNA hybridisation to detect parasites were discussed by many authors. D.Olivera et al. (1995) reported the detection of *T. annulata* in cattle using (PCR).

Two integrated approaches were developed to detect several *Theileria* or *Babesia spp*, in one assay (Figueroa et al., 1993; Allsopp et al., 1993). Using these approaches multiple species can be detected in one assay without performing independent PCR for each parasite (Gubbels et al., 1999). PCR combined with reverse line blot (RLB) hybridization (Gubbels et al., 1999) is used to detect and differentiate all known *Theileria* and *Babesia spp*. on bases of their differences in 185 subunit rRNA gene sequences (Gubbels et al., 1999). A similar approach has been followed for detection and differentiation of *Anaplasma spp*. Targeting the 165 rRNA gene (Jongejan, 2003).

1.5.1.3 Diagnosis of microfilaria

Detection of microfilaria in blood can be done by concentration method after centrifugation of blood in micro hematocrit tube or in wet smear covered with a cover slip. The larva may be detected by the snake-lie movement under low magnifications (Jain, 1986). The recommended method for stained blood film consists of adding 1.0ml of fresh blood to 10ml of 2% formalin solution and centrifuged at 1,000-1,500 rpm for few minutes. The sediment is examined microscopically as a wet smear after being mixed with an equal volume of 1:1000 methylene blue (Jain, 1986). A drop of serum in slide covered with cover slip examined for viable larvae (Jain, 1986).
1.5.1.4 Diagnosis of internal parasites

1.5.1.4.1 Gross examination
Feecal samples should be examined for any intact specimens such as Moniezia spp. segment and Oesophogostomum species adults. Examination of the smear only indicates the presence of infection regardless of its quantification (Dunn, 1978).

1.5.1.4.2 McMaster Technique
Mc Master Technique depends on the examination of a precise volume of suspension of faeces in floatation solution, to allow an estimation of the number of eggs and larvae present in a sample. The natures of solution vary according to the animal origin of the suspected material and mixing performed in various ways. The essential equipment is a slide that consists of two layers of glass separated by a known distance and having on the upper layer a ruled squire of known area (King, 1976).

1.5.1.4.3 Concentration methods
Concentration depends on specific gravity of the eggs and is not reliable in estimating the intensity of an infection, and can be achieved by sedimentation or floatation (King, 1976).

1.5.1.4.3.1 Sedimentation
The parasite eggs do not float, but deposit in the solution either by slow natural precipitation of faecal suspension or by the use of centrifugation. This method is relevant to fascioliasis, schistosomiasis and paramphistomiasis (King, 1976).
1.5.1.4.3.2 Flotation
In this method the specific gravity of the solution is higher than the specific gravity of the eggs. Thus the solution used is at saturation or semi-saturation such as sodium chloride and sugar (sucrose). The method is used for nematodes.

1.6 Control
1.6.1 Control of sheep Trypanosomosis:
1.6.1.1 Treatment of Trypanosomosis:
By using trypanocidal drugs for the treatment and or prevention is the most widely accepted method for controlling the disease (Tacher, 1982; Losos, 1986).
Chemoprophylactic drugs are used in highly tsetse infested areas and the only difference from curative drugs that in case of prophylaxis the drug persist longer (Uilenberge, 1998).
The available and common trypanocidal drugs are Diminazen-acturate (Berenil), Quinapyramine sulphate and chloride (Antrycide) and Isometamidium (Samorin).

1.6.1.2 Vector control:
In vector control several methods were applied, these are including bush clearance to minimize the density of flies by destroying the tsetse shelter and resting sites (Ford, 1970; Finelle, 1974; Walker, 1986). This method is seldom used now (Finelle, 1974). Elimination of game animals in order to starve tsetse flies by reducing the source of food (Ford, 1970). Due to the world concern to conservation wild life, the method no longer used.
1.6.1.3 Use of insecticides:
Application of insecticides like chlorinated hydrocarbons chiefly DDT and dieldrin in the past (Finelle, 1974), organophosphorus and pyrethroids are applied in ground or aerial spraying. This is most effective method (Allsopp, 1984). Synthetic pyrethroid is also applied by dipping or used as pour on, depending on the particular insecticide used, ticks and other ectoparasites may also be reduced. The use of traps and insecticide-impregnated targets with or without attractants is a method to suppress tsetse populations (Challier and Laveissiere, 1973; Vale, 1974, 1993; Brandl, 1988; Bauer et al., 1995).

1.6.1.4 Biological control:
Recently application of sterile insect technique has been achieved successfully in Zanzibar by systematic releases of sterile male among the target population (Feldmann and Hendrichs, 2001). This method is very specific and not polluting (Uilenberg, 1998).

1.6.1.5 Tabanids control:
The most suitable method to control tabanids is the use of chemical attractants to trap males, this help to reduce the disease out side the tsetse belt (Mohammed et al., 2000).

1.6.2 Control of Ticks and tick-borne diseases
1.6.2.1 Treatment
1.6.2.1.1 Chemotherapy
Usage of ox tetracycline and chlortetracycline are affective in arresting macro- and micro schizonts formation in the beginning of the infection of Theileriosis and also used for treatment of anaplasmosis (Sousby, 1982).
Diminazene aceturate (Berenil) at a dose of 3.5 mg/kg B.W intramuscularly in case of Babesiosis and combined with oxytetracycline 15mg/kg B.W. for theileriosis treatment.

Halofuginone lactate at 1.2 mg/g B.W. given orally shown to be highly effective for theileriosis (Schein and Voiget, 1979).

Parvaquone (Clexon) is effective at 10 mg/kg B.W. administered intramuscularly in two injections with 48 hours interval (Gille et al., 1984; MacHardy and Morgan, 1985; Musisi et al., 1985; Mehta et al., 1987 and Unsuren et al., 1988).

Buparvaquone (Butalex) is twenty times more effective than parvaquone, it is given at 2.5 mg/kg B.W. (McHardy et al., 1985).

Imidocarb (Imizol) is used as chemotherapy and also eliminate anaplasmosis from carrier animals (Roby and Mazzola, 1972) cited by Soulsby (1982).

1.6.2.1.2 Chemoprophylaxis

By subcutaneous inoculation of ground suspension of infected tics with a subsequent intramuscular injection of oxytetracycline (Malik et al., 1987).

1.6.2.2 Vaccination

Vaccination against tropical theileriosis is established in some parts of the world namely Israel, Turkey, Iran and Iraq (Soulsby, 1982 and Losos, 1986) attenuated vaccines obtained by serial passage of schizont infected lymphocyte, and this provided a significant protection (Srivastava and Sharma, 1977; Broun, 1979). Development of vaccine against tropical theileriosis in cattle and malignant ovine theileriosis in sheep in Sudan is needed to be evaluated experimentally (Jongejan, 2003).
1.6.2.3 Control of ticks:
Using acricesdes in dips for large herds and hand spray or used as pour on (Drumond, 1976; Losos, 1986a).

1.6.3 Treatment of microfilaria
Many broad spectrum anthelmintics have a high efficiency against Microfilaria (Drudge et al., 1969), one of those drugs, is Ivermectin, it is a drug of choice to eliminate Microfilaria in horses (Pollitt and Holdworth, 1986) at 0.2mg\ kg B.W.
Other drugs include Diethyl carbamazine a microfilaricidal in both man and animals at a dose of 5-8 mg\ kg B.W. daily for 21 days. Also systemic corticosteroids are recommended (Cello, 1971).

1.6.4 Control of internal parasites
Fischer and Say (1989) explained that the control of gastrointestinal parasites depends mainly on drug prophylaxis for eliminating the parasites by regular treatment. The animal should be given antihelmintics at the end of the rainy season in order to improve the adaptation of the animal to harsh dry season conditions. A second treatment by antihelmintics should be given at the end of the dry season so that the infection of pasture by parasites at the time of the first rains can be reduced.
On the other hand, Thursfiled (1996) described that the level of infection with some nematodes can be reduced by mixed, alternate and sequential grazing.
CHAPTER TWO
MATERIALS AND METHODS

2.1 Study sites description
The study was conducted in Khartoum State which is situated in Northern Sudan between latitude 16°N and 14°N. The total area extends over approximately 21,000 square kilometers. Khartoum state contained three basic Towns (Khartoum, Khartoum North and Omdurman), each of them is divided administratively into a number of localities. One slaughter house was selected randomly from each town to be the site for the study, Al Sahafa abattoir represented Khartoum, Ghanawa abattoir represented Omdurman and Kuku abattoir represented Khartoum North. The selection was done on the basis of the number of animals slaughtered, as these are the largest in the three towns also the animals are brought from all over the country to these slaughter houses.

2.2 Sampling
Sampling was done according to Thrusfield (1995), the slaughter houses were selected from Khartoum state (Khartoum, Khartoum North and Omdurman). All animals in each slaughter house were sampled at the time of the visit, this samples collection method called Cluster sampling or Two-stage sampling method.

2.3 Study population
All sheep from different origins, in different age group and sex brought to slaughter house at the time of visit were targeted as study population.
2.4 Samples collection
For blood and internal parasites detection, blood samples, faecal samples were collected, tick infestation was observed, and body temperature was taken, information on origin, breed, sex and age were recorded for each animal.

2.4.1 Blood sample collection
A total of 150 blood samples were collected from the ear vein of sheep for both thin blood smear and wet amount examinations. Samples were placed in a cool box and transferred to the laboratory before processing for parasitological examination.

2.4.2 Faecal samples collection
Fresh faecal samples were collected from the rectum of every individual sheep in plastic vacutainer. The samples were labeled and immediately transferred to the laboratory for faecal examinations.

2.4.3 Ticks observation
Ticks were observed on individual selected animals according to the presence or absence.

2.5 Parasitological examination
2.5.1 Wet blood mount:
One drop of fresh blood was placed on a slide, covered with a cover-slip and examined microscopically for detection of motile parasites at 10×40 magnification.

2.5.2 Thin blood film:
Thin blood films were prepared on slides, dried and fixed with absolute alcohol. Then these smears were stained with 5% diluted giemsa stain
solution for 45 minutes. Films were washed using distilled water, dried and examined microscopically under oil immersion at 10×100 magnification for blood parasites detection.

2.5.3 Faecal examination

2.5.3.1 Flotation method
Two to three grams of the faeces were taken in a mortar, ground and mixed thoroughly in a saturated sodium chloride solution. The suspension was poured through a tea sieve into a beaker to remove the large particles. The solution was poured into a small bottle until it was completely filled to make a convex meniscus at the top. Then it was covered with a clean grease-free cover slide. The cover slide was removed after 10 minutes and placed on a clean slide to be examined under Low power 10 × 20 magnifications. The examination was done systemically to cover all the cover slip.

2.5.3.2 Sedimentation
Two to three grams of the faeces were mixed with water and put in tubes. The tubes were centrifuged three times for 5 minutes, each supernatant fluid was removed and replaced each time. The deposits were taken and placed on slides with covers slip and examined microscopically at high power 10× 40 magnifications for detection of parasites ova.

2.6 Data analysis
Microsoft Excel (windows 2003) and state 6.0 for windows 98/95/NT were used for data analysis. Chi-square (χ^2) was used for assessing the statistical associations of various factors for presence of blood and internal parasites. Logistic regression model was employed to obtain the
odds ratio (OR) only for those factors which gave statistical significant by using chi-square ($\chi^2$).

If the odds Ratio was greater than one the factor could be a risk factor for the presence of blood or internal parasites.
Table (2.1) Description of the study population

<table>
<thead>
<tr>
<th>Slaughter House</th>
<th>No. of animal examined</th>
<th>Origin</th>
<th>Breed</th>
<th>Sex</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>White</td>
<td>Gadaref</td>
<td>Kordofan</td>
<td>Darfur</td>
</tr>
<tr>
<td>Elsahafa</td>
<td>50</td>
<td>-</td>
<td>45</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Ghanawa</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>26</td>
<td>24</td>
</tr>
<tr>
<td>Kuku</td>
<td>50</td>
<td>40</td>
<td>-</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>150</td>
<td>40</td>
<td>45</td>
<td>41</td>
<td>24</td>
</tr>
</tbody>
</table>
Chapter Three

Results

The results showed that, the prevalence of blood parasites in Khartoum state was 15.3% (n=150) with 18% (n=50), 16% (n=50) and 12% (n=50) in Omdurman, Khartoum North and Khartoum respectively (Table 3-1).

Also the prevalence of internal parasites was 32%, 28% and 22% in Khartoum North, Omdurman and Khartoum respectively (Table 3-1).

Ticks presence observed was 16%, 8% and 8% in Omdurman, Khartoum and Khartoum North respectively (Table 3-1).

No motile parasites were detected (Table 3-1), high temperatures were observed only in Omdurman with 6% prevalence rate (Table 3-1).

The highest prevalence rates was due to *Theileria* spp., 12%, 14% and 18% in Khartoum, Khartoum North and Omdurman respectively with 14.7% total prevalence (Table 3-2). Only one animal showing *Babesia* spp was detected in Khartoum North (2% prevalence rate as 0.6% of total rate) (Table 3-2). Tick infestation was observed at 8%, 16% and 8% prevalence rates in Khartoum, Omdurman and Khartoum North respectively, with 10.7% total prevalence rate.

On the other hand results of internal parasites indicated the presence of protozoa, nematodes, cestodes and trematodes, (*Eimeria, Hemoncus, Strongyloide, Monezia and Fachiola spp*). Trophozoites or eggs were detected in fecal examinations with prevalence rates 12%, 8%, 2.6%, 4% and 0.7% respectively (Table 3-3).

*Coccedia spp* prevalence rate was the highest (10%, 16% and 10% in Khartoum, Khartoum North and Omdurman respectively) (Table 3-3). The prevalence of *Heamonchus spp* was 6%, 8% and 10% in Khartoum, Khartoum North and Omdurman respectively (Table 3-3).
2%, 4% and 6% were the prevalence rates of *Monezia spp* in Khartoum, Khartoum North and Omdurman respectively (Table 3-3). *Strongyloides* prevalence was 4%, 2% and 2% prevalence rates in Khartoum, Khartoum North and Omdurman respectively (Table 3-3). *Fasciola* was found in only one sample from Khartoum North with 2% prevalence rate (Table 3-3).

Statistical analysis showed no correlation between prevalence of blood parasites and place of origin ($\chi^2 = 3.7027, p=0.295$), age ($\chi^2 = 4.047, p = 0.132$), sex ($\chi^2 = 0.915, p = 0.339$), breed ($\chi^2 = 3.065, p = 0.216$) and ticks presence ($\chi^2 = 0.640, p = 0.424$) (Table 3-4).

Also there are no relation between presence of internal parasites and origin ($\chi^2= 2.023, p = 0.568$), age ($\chi^2= 0.585, p = 746$), sex ($\chi^2=0.321, p = 0.571$) and breed ($\chi^2 = 0926, p = 0.629$) (Table 3-5).

A strong association was found between presence of blood parasite and temperature (t-test = -628.515, $p = 0.000$) (Table 3-6).
Table (3.1): Parasitic Burden of Animals Examined

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Location</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Khartoum</td>
<td>Omdurman</td>
<td>Khartoum</td>
<td>Total</td>
</tr>
<tr>
<td>No of animal examined</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>Body temp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>100%</td>
<td>94%</td>
<td>100%</td>
<td>98%</td>
</tr>
<tr>
<td>High temp.</td>
<td>_</td>
<td>6%</td>
<td>_</td>
<td>2%</td>
</tr>
<tr>
<td>Tick presence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>8%</td>
<td>16%</td>
<td>8%</td>
<td>10.7%</td>
</tr>
<tr>
<td>Blood parasites</td>
<td>12%</td>
<td>18%</td>
<td>16%</td>
<td>15.3%</td>
</tr>
<tr>
<td>Stained blood film</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedimentation method</td>
<td></td>
<td></td>
<td></td>
<td>0.6%</td>
</tr>
<tr>
<td>Internal parasites</td>
<td>_</td>
<td>_</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Floatation method</td>
<td></td>
<td></td>
<td></td>
<td>26.7%</td>
</tr>
<tr>
<td>Internal parasites</td>
<td>22%</td>
<td>28%</td>
<td>30%</td>
<td></td>
</tr>
</tbody>
</table>
Table (3.2) the prevalence of blood parasites in slaughter houses in Khartoum state

<table>
<thead>
<tr>
<th>Slaughter house</th>
<th>No. of animal examined</th>
<th>Prevalence %</th>
<th>Theileria spp</th>
<th>Babesia spp</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No. (%)</td>
<td></td>
</tr>
<tr>
<td>Elsahafa</td>
<td>50</td>
<td>6(12%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kuku</td>
<td>50</td>
<td>7(14%)</td>
<td>1 (2%)</td>
<td></td>
</tr>
<tr>
<td>Ghanawa</td>
<td>50</td>
<td>9(18%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Over all prevalence</td>
<td>150</td>
<td>22(14.7%)</td>
<td>1 (0.6%)</td>
<td></td>
</tr>
</tbody>
</table>
Table (3.3): The prevalence of internal parasites in slaughter houses in Khartoum state

<table>
<thead>
<tr>
<th>Slaughter house</th>
<th>Eimeria spp No. (%)</th>
<th>Heamonchus spp No. (%)</th>
<th>Strongyloides No. (%)</th>
<th>Monezia spp No. (%)</th>
<th>Fasciola No. (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elsahafa</td>
<td>5 (10%)</td>
<td>3 (6%)</td>
<td>2 (4%)</td>
<td>1 (2%)</td>
<td>_</td>
<td>11 (22%)</td>
</tr>
<tr>
<td>Kuku</td>
<td>8 (16%)</td>
<td>4 (8%)</td>
<td>1 (2%)</td>
<td>2 (4%)</td>
<td>1 (2%)</td>
<td>16 (32%)</td>
</tr>
<tr>
<td>Ghanawa</td>
<td>5 (10%)</td>
<td>5 (10%)</td>
<td>1 (2%)</td>
<td>3 (6%)</td>
<td>_</td>
<td>14 (28%)</td>
</tr>
<tr>
<td>Total</td>
<td>18 (12%)</td>
<td>12 (8%)</td>
<td>4 (2.6%)</td>
<td>6 (4%)</td>
<td>1 (0.7%)</td>
<td>41 (27.3%)</td>
</tr>
</tbody>
</table>
Table (3.4): The relationship between presence of blood parasites and origin, age, sex, breed and tick infestation.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Chi-square($\chi^2$)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>3.7027</td>
<td>0.295</td>
</tr>
<tr>
<td>Age</td>
<td>4.047</td>
<td>0.132</td>
</tr>
<tr>
<td>Sex</td>
<td>0.915</td>
<td>0.339</td>
</tr>
<tr>
<td>Breed</td>
<td>3.065</td>
<td>0.216</td>
</tr>
<tr>
<td>Ticks</td>
<td>.640</td>
<td>0.424</td>
</tr>
</tbody>
</table>
Table (3.5): The relationship between presence of internal parasites and origin, age, sex and breed.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Chi-square ($\chi^2$)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>2.023</td>
<td>0.568</td>
</tr>
<tr>
<td>Age</td>
<td>0.585</td>
<td>0.746</td>
</tr>
<tr>
<td>Sex</td>
<td>0.321</td>
<td>0.571</td>
</tr>
<tr>
<td>Breed</td>
<td>0.926</td>
<td>0.629</td>
</tr>
</tbody>
</table>
Table (3.6): The association between presence of blood parasites and animal body temperature

<table>
<thead>
<tr>
<th>Factor</th>
<th>No of animals examined</th>
<th>SE</th>
<th>t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>150</td>
<td>0.503</td>
<td>-628.515</td>
<td>0.000**</td>
</tr>
</tbody>
</table>

**: highly significant (P< 0.01)

NB. Normal body temperature ranged 39°c- 40 °c according to Radostits et al (2000).
Chapter Four
Discussion

The study showed no Trypanosomiasis infection in the samples examined. That agrees with different workers (Stephen, 1970 and Findle, 1973) who stated that sheep and goats are seldom infected with trypanosomes under natural conditions. Khasanove and Tranitskaya (1973), Mahmoud and Elmalik, (1978) established experimental infection of Trypanosoma and showed that sheep and goats may act as reservoir and may be important in the transmission of trypanosomosis, Karib (1961) stated that thousands of sheep and goats were examined in the Upper Nile Province but only T.vivax was identified. Boid et al (1981) suggested the role of sheep in Kassala Province as reservoir after he found antibodies against T. evansi circulating in their blood. On the other hand the study revealed a higher prevalence of Thieleriosis compared to Babesiosis. Radositits et al (2000) cited that in an outbreak of Thieleria infection involving 8 flocks, 22% of sheep were affected and all of them died within 3-6 days. Losos (1986) reported that Theileria hirci in Africa, Asia and Europe causes enzootic diseases; The young lambs contract a relatively mild form of the disease which renders mature animal immune; The mortality rate in sheep is relatively low about (16%) in infected cases; The distribution of T.ovis is comparable to the distribution of T.hirici. In general piroplasmosis in Sudan was early reported in the beginning of past century and Babesiosis was reported in 1905, yet limited research was done such as the work by Hoogstrsal (1956), FAO (1983), Abdoun (1984) Hashim (1984) Mohamed and Yagoub (1984).

The results of the present study showed high prevalence rate of internal parasites infection (Coccidiosis, Monezia infection, Strongyloid infection, Haemonchosis and Fsciolosis), the protozoa were the most common and they belonged to the genera Eimeria spp. (Coccedia.)
Similarly, Osman, et al (1990), reported outbreaks of coccidiosis among sheep and goats in fattening centers around Khartoum state. Other workers recorded the presence of internal parasites of sheep in Sudan, in Kordofan, Kassala, Darfur and Blue Nile provinces. Gagoad and Eisa (1968) examined 322 abomasums of sheep, their study showed that 80% of sheep harbored *Haemonchus contortus*. They reported that the incidence rate in Kordofan, Kassala, Darfur and Blue Nile was 83%, 73.5%, and 75% respectively. Eisa and Ibrahim (1970) examined gastrointestinal tracts of sheep obtained from Elobied, they reported the occurrence of *H. contortus, T. colubriformis, S. papillosus, O. columbianum, Chabertia ovina, Cooperia pectinata, Trichuris ovis and M. expansa*. *H. contortus* was found to be the most prevalent species.

This study revealed that there was no effect of sheep place of origin on the prevalence of blood and internal parasites that might be due to similarities of management conditions in various areas of origin, (White Nile, Gadaref, Kordofan and Darfour). Also sheep in various locations may meet in different occasions during seasonal migrations of herds.

Negative relationship was obtained between ticks infestation and blood parasites infection. This could be attributed to the fact. That ticks dropped during the period of travels.

Also the study revealed that there was no effect of breed on the prevalence of blood and internal parasites ($\chi^2 = 0.005, p > 0.05$). That could be attributed to the fact that the animals examined were genetically more than 65% of the sheep in Sudan are of the Sudan Desert type (*Ovis aries*) (Sulieman et al., 1990), which is believed to be a descendant of sheep of Egyptian origin (*Ovis longipes*). Therefore the so called breeds may be types rather than distinct breeds. Sudan Desert sheep are further classified into tribal subtypes, e.g. Hamari, Kabashi, Shenbali in North and West Kordofan States (Mukhtar, 1985), Shugor, Dubasi and Watish
in the Central States (Sulieman et al., 1990) and Bourug in the Butana area of eastern Sudan.

No correlation ($\chi^2 = 0.483, p > 0.05$) was found in this study between sex and presence of blood and internal parasites. Similar results were reported by Flach et al. (1993), who stated that there was no relationship was established between infection of engorged nymphs of ticks and sex of host animal. Thus sex is not a determining factor in susceptibility to tick-borne parasites. Both sexes graze in same under similar field conditions which may explain the negative correlation between sex and internal parasites.

This study was conducted in the hot season (April, May, June), when the ova and egg and worm counts decreased, while both high faecal egg output and high worm counts were observed during the rainy season. This could be attributed to the suitability of environmental conditions of moderate temperature and moisture prevailing during the rainy season (Temp 28-31°C; RH 37.5-70%) providing optimum requirements for development of infective nematode larvae (Pandey, 1990; Onyali et al., 1990; Agyei, 1991; Rahman, 1992). Both egg and worm counts decreased at the end of the rainy season and this might be due to a self-cure phenomenon as these animals have been sensitized for several months during the rainy season and subsequently lost their worm burdens (Altaif et al., 1980; Altaif and Issa, 1983; Chaudhry et al., 1988). This decrease continued throughout winter and summer and was probably induced by dryness. This fact is in conformity with observation of several authors in some African countries such as Nigeria. Okon and Enyenih (1977), Ogunsusi (1979), and Chiejina and Fakae (1984) studied pasture infectivity with trichostrongyloid larvae in that country and showed that the dry season was unfavourable for pre-parasitic development and survival of nematode larvae. In Tanzania, Connor et al. (1990) reported
that egg output declined and remained low during the dry season due to lack of moisture. In addition Chiejina et al. (1989) reported that the dry season is responsible for the rapid drying out of faecal pellets leading to death of parasite eggs and larvae. On the other hand sheep brought to Khartoum state came for local and export marketing, which means owners select healthy, youngest and fit animals. Also this study was conducted on relatively small number of sheep (150) compared with total number brought to the state annually for export and local consumption. According to MARF (2005) in the last five years from 2000 to 2004, more than 76 millions head of sheep were slaughtered for local consumption and 480 thousands ton were exported. With the above mentioned in this study the results showed that high prevalence of blood parasites (15.3%) and (27.3%) with regards to for internal parasites, which are very harmful for man and sheep, with regards to helth and economy, there is direct loss from expected condemnations of affected parts and decrease in animal proteins available for human consumption so it is vital to:

1- Pay more attention to sheep blood and internal parasites, epidemiology and control nation wide.

2- Conduct similar surveys for blood and internal parasites, to cover all animals brought from various states of Sudan to Khartoum for local and international consumption.

3- Apply practical methods of prevention and control such as use of chemotherapeutic control, vector control and continuous veterinary monitoring in the slaughter houses especially in ante-mortum inspection.

4- Draw attention to the exported sheep and try to minimize losses in production due to the parasites.
REFERENCES


Wilson, R.T., 1991. Small ruminant production and small ruminant genetic resources in tropical Africa (FAO) Animal Production and Health Paper No. 18; Food and Agriculture Organization of the United Nations, Rome
