بسم الله الرحمن الرحيم

Sudan University of Science and Technology

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Distribution and Risk Factors Associated with Tick Infestation in Goat, In River Nile State, Sudan

توزيع وعوامل الخطرالمرتبطه بمعدل إنتشار الإصابة بالقراد في الماعز في ولاية نهرالنيل، السودان

A Thesis submitted to the College of Graduate Studies in Partial Fulfillment of the Requirement for the Degree of Master in Preventive Veterinary Medicine (M.P.V.M)

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الآيـــــة

قال تعالي :

{كُلُوا وَارْعَوْا أَنْعَامَكُمْ إِنَّ فِي ذَلِكَ لَآيَاتٍ لِّأُوْلِي النُّهَى }

صدق الله العظيم

طه – الآية 54

Dedication

TO my father and mother

TO my brothers and sisters

TO my husband and my lovely kids

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List of content

No	Subject	Page
	Quoran	I
	Dedication	II
	Acknowledgement	III
	Table of contents	VII
	List of table	VII
	List of figures	VIII
	English abstract	X
	Arabic abstract	VIII
	INTRODUCTION	1
	CHAPTER ONE	
1.0	**Literature Review**	3
1.1	The ticks	3
1.2	Tick's Taxonomy	3
1.3	Morphology of ticks	4
1.4	Ticks Biology	4
1.4.1	Tick life cycle	4
1.4.1.1	One-host tick	5
1.4.1.2	Two-host tick	5
1.5	Ecology	5
1.6	Tick distribution in the Sudan	7
1.7	Economic importance of ticks	9
1.7.1	Direct effects	9
1.7.2	Toxicosis	9
1.7.3	Transmission of diseases	10
1.8	Tick-borne diseases of importance	11
1.8.1	Tick-borne Protozoan Diseases	11
1.8.1.1	Theileriosis	11
1.8.1.1.1	Theileriosis in goats	11
1.8. 1.2	Babesiosis	12
1.8. 2	Tick-borne Rickestial Diseases	12
1.8.2.1	Anaplasmosis	12
1.8.2.2	Heart water	13
1.8.3	Tick-borne Bacterial Diseases	14

1.8.3.1	Dermatophilosis	14
1.8.3.2	Bovine Farcy	14
1.8. 4	Tick-borne Viral Diseases	15
1.8.4.1	Nairobi sheep disease	15
1.8.4.2	Louping ill	15
1.8.5	Tick Toxicosis	15
1.9	Tick control	16
1.9.1	Host resistance	16
1.9.2	Chemical acaricide	17
1.9.3	Biological control	18
1.9.4	Ecologically based strategies for tick control	19
1.9.5	Chemotherapeutical control	19
1.10	Vaccination against ticks and Some TBDs	20
	CHAPTER TWO	
2.0	**Materials and Methods**	21
2.1	Study area	21
2.2	Sample Collection and Identification	21
2.3	Questionnaires	22
2.4	Data Analysis	22
	CHAPTER THREE	
3.0	**Results**	24
3.1	Tick survey	24
3.2	Prevalence of tick infestation	24
3.3	Prevalence of ticks and association with risk factor	27
3.4	Regression analysis	31
	CHAPTER FOUR	
4.0	**Discussion**	33
4.1	Conclusion	37
4.2	Recommendation	38
4.3	References	39-54
4.4	Appendix	55-56

List of table:-

No	Subject	page
1	prevalence of tick infestation in goat in fifth localities	24
2	Prevalence of tick infestation in goats according to species	25
3	Distributions of ticks species with predilection site and male to female ratio in goat	25
4	tick burden of goats	26
5	Number and sex of ticks infested in predilection site of host	26
6	Rate (%) of tick infestation in Predilection site of goat	27
7	chi-square analysis for risk factors associated with tick infestation of (N=150) goat in River Nile stat e	30
8	Regression analysis for risk factors	32

List of Figures: -

No	**Subject**	**Page**
1	Study area map	23

List of appendices:-

Appendix	Title	Page
1	Questionnaire	55

Abstract

Across sectional study was conducted from June 2018 to December 2018 in the River Nile State, Sudan to discerning the prevalence of tick infesting goats and to investigate relationship between tick infestation and the Risk factors (district, herd size, housing type, raising system, feeding type ,breed, sex, age and coat color, Predilection site, control, method of control and manure remove. 150 goats were selected randomly from fifth locality: Shendi , El-matmah , Ad-Damer, Atbara and Berber, The results indicated the prevalence of tick infestation rate in goat (30%) , also indicated ,two tick genera and five species were found.

Analysis risk factors by chi-square test and the result showed association with tick infestation positive association was recorded for following factors: District, housing type, feeding type Predilection site, control, method of control and manure remove.

Outline high prevalent ticks in study area and had bad economic impact, therefore more attention is needed to minimize tick distribution and control it.

مستخلص

أجريت دراسة مقطعية في الفتره من شهر يونيو2018 حتي ديسمبر2018 السودان ، ولايه نهر النيل وذلك لمعرفه معدل انتشار القراد في الماعز والتقصي حول عوامل الخطر المرتبطه به من العوامل الاتية: المنطقة ، حجم القطيع ، نوع الايواء، نظام الرعى نظام التغذية ،السلالة ، الجنس ،العمر، لون الطبقة ، موقع الالتصاق ،الموسم ، التحكم والمكافحة ، طرق المكافحة و ازالة المخلفات .

تم إ ختيار 150عينة عشوائيا من خمس محليات بالولاية شندي المتمه الدامر ، عطبره، بربر.

واظهرت الدراسة أن معدل انتشار القراد في الماعز(30%) وقد تم التعرف علي عائلتين وخمس أنواع من القراد. لمعرفه عوامل الخطر المرتبطه بالقراد تم استخدام مربع كاي حيث تم تسجيل الارتباط الايجابي للعوامل الاتيه: المنطقه ،نوع الايواء، نوع التغذيه ، مواقع الالتصاق، التحكم والسيطرة ، طرق التحكم وازاله المخلفات و أظهرت الدراسه أن معدل أنتشار القراد عالي في المنطقه وله اثر اقتصادي سئ لذلك لابد من الاهتمام بالمكافحه وتقليل خطر إنتشاره.

INTRODUCTION

Ticks infesting livestock in the Sudan are species of the genera *Amblyoma*, *Hyalomma*, *Boophilus* and *Rhipicephalus* (Hoogstral, 1956).

The Sudanese tick fauna comprises 68 tick species (Osman 1978; Jongejan *et al*., 1987), many of which have veterinary importance.

Medical and veterinary implications of ticks (Acari: Ixodidae) on human and animals life is very obvious question and proved from many years ago (Hoogstraal, 1982).

Ticks may have both direct and indirect adverse effects on their host animals. They feed on blood, leading to anemia, and the injuries caused by their attachment damage hides and predispose animals to secondary bacterial infections that may lead to mastitis. These wounds may also be attractive to the myiasis-causing flies. Ticks can cause paralysis and probably transmit a greater variety of organisms that cause diseases than any other arthropod (Hoogstraal, 1956).

Ticks and tick-borne diseases (T&TBDs) are major constraints to livestock improvement in many parts of the world especially in the tropics (Walker *et al*., 2003).

The study of ticks that parasitise domestic animals is of considerable importance in that it assists in determining their host preference, their seasonality and geographic distribution, the diseases they may transmit and their control (King, *et al* .,1988).

Hassan (1997) found that survival of ticks under direct sunlight was significantly shorter compared to those in the shade.

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Tick and tick-borne diseases of sheep and goats are less well studied than those of cattle. Nevertheless, small ruminants are able to acquire resistance to most tick species and principles of enzootic stability and the need to preserve it are similar to those in cattle (Tatchell, 1997).

Hoogstraal (1956) conducted the first systematic studies on ticks in the Sudan.

The main objectives of this study were:

1. To determine the prevalence of tick infestation in goat.
2. To identify the common tick species in the study area.
3. To assess the major risk factors associated with occurrence of tick infestation on the goat in the study area.

CHAPTER ONE

LITERATURE REVIEW

1.1. The ticks:

Atick is blood sucking parasite which parasitize on mammals, reptiles and birds. It is one of the members of group of arachnids, the ticks are found in most parts of the world but are generally limited to those habitats by their hosts namely, and to woods, tall grasses, crevices and vegetation where they climb and wait to cling on a host (Oleg Kozhukhov, 2007). There are two families of ticks, the family Argasidae (soft ticks), which lacks scutum and the dorsum is covered by leathery integument and the family Ixodidae (hard ticks) whose scutum or dorsal shield covers.

1. 2. Tick's Taxonomy:

There are about 900 different species of ticks. Most of which belong to the one of two main families, the Argasidae (Soft ticks) and the Ixodidae (Hard ticks) (Barker, 2004).

Ticks are classified according to their morphological feature into: Phylum: Arthropoda Sub phylum: chelicerata (anterior fangs/chelicerae)

Class: Archanidae (Scorpion, Spiders, Harvestmen, Ticks and mites)

Order: Acarina (Parasitifornes, Ticks and Mites)

Suborder: Ixodiodea (Ticks)

Family (1): Argasidae (Soft tick)

Genus: *Argas, Otobius, Ornithodros*

Family (2): Ixodidae (Hard tick)

Genus: *Amblyomma, Hyalomma, Boophilus, Dermacenter, Heamaphysalis, Ixodes, Margroous, Rhipicphalus, and Aponoma.*

Family (3): Nuttaliellidae

Genus: *Nuttalliella*

1.3. Morphology of ticks:

Ticks of the family Ixodidae, in adult's dorsal side is covered by scutum. Tick body is comprised of three major segments: capitulum, idiosoma (body), and legs. Capitulum includes chelicerae, palps, and hypostome.

Ventral side of the hypostome is covered by rows of recurred teeth that help to penetrate the epidermis of the host during blood feeding. Idiosoma contains legs, genital pore, and internal organs. Adults and nymphs had four pairs of legs, while larvae had only three pairs.

In hard in female ticks, scutum covers the anterior third of the dorsal side, while in males the scutum it extends over the entire dorsum of the idiosome (Sonenshine and Roe, 2014)

1.4. Tick's Biology:

The different stages of a tick's development can be mistaken for a different species of tick.

Life cycle of the ticks: Eggs, larvae, nymph and adult.

1.4.1. Tick life cycle

The life cycle of tick include according to feeding habitat and on number of host individuals. (Suad,2009) wrote; the Argasid species are multi-host feeding pattern, where as the life cycle of most Ixodid species typically involves a 3-host cycle, some species have a 1or 2 host cycle. According to the number of the

hosts they require during their life cycle, ticks can be classified into three groups:

1.4.1.1. One-host tick:

One Host Ticks: in which case moulting occur through stage on the same host such as, *Ripicephalus decloratus* (Walker, *et al*., 2003)

1.4.1.2. Two-host tick:

In these species the nymph drops off to moult to the adult stage,which then find another host.

A few species in the genera *Hyalomma* and *Rhipicephalus*, (e.g. *H. rufipes* and *R. evertsi evertsi)* Living in regions with long dry or cold seasons, and irregularly available hosts have a 2-host life-cycle (Kettle, 1995)

1.4.1.3. Three-host tick:

The larvae, nymphs, and adult feed on different host individuals example, *Amblyomma spp,Rhipiceghalus apendiculatus*(Soulsby,1982)

In many instances larvae and nymphs of most species feed on small mammals (rodents) or birds, while adults prefer larger hosts (Suad, 2009).

1.5. Ecology:

Tick population and their distributed through out the world vary according to their adaptability to ecology, eco-climate, microhabitats ambient temperature, rainfall and relative humidity which are critical factors affecting life cycle of ticks as stated by (Tatchell and Eastorn, 1986). The relative humidity, on the other hand, remains an important factor for survival of ticks by regulating the water balance and prevents dehydrations (Hassan *et al.,* 2003). He also stated that the high humidity is particularly

more required for survival of Ixodid ticks than the Argasid ticks. Ixodid ticks quickly die of desiccation when exposed to humidity below critical equilibrium values.

Schulze *et al*., (2001) Reported that; *Ixodes scapularis* tended to quest earlier and later in the day when temperatures were low and the relative humidity higher.According to that humidity plays an essential role in ticks activities and survival. Rainfall factor is also which has a significant role in tick's distribution through out the world. The effect of the rainfall on ticks challenge to their hosts was investigated at Kyle Recreational Park in Zimbabwe (Mooring *et al.*, 1994*)* ,they found that *R.appendiculatus* adult infestation on host were 2-3 times more during the high rainfall and They concluded that ticks burden on hosts are high during the wet season due to high rainfall.

Vegetation also provides the shade and optimum humidity in microclimate habitats of ticks enhancing their survival during adverse situation (Hassan, 2003).

Age grading of ticks requires theoretical adaptation because of fundamentally different relationship between feeding and transmission opportunities of insect and tick (Zahid *et al*., 2006).

Estrada–Pena (2001) found that; seasonal dynamics exert a major influence on the dynamics of transmission of tick-borne pathogen.

Chaka et al., (2001) studied; determination of the physiological age of *R. appendiculatus*. The age of apopulation of vectors of disease pathogens is a most useful characteristic for epidemiological studies.

1.6. Tick distribution in the Sudan:

In the Sudan, tick is include 64 species and subspecies of both Ixodid and Argasid ticks (Hoogstraal, 1956).

Ticks occupy a wide range of ecological niches that form the climate of the country. According to Hoogastraal (1956),

Most Sudanese tick collections were made from Equatoria region, the distribution of *A. lepidum* in the Sudan is generally concentrated in the eastern parts of the country (Osman and Hassan, 2003). This tick is absent from Northern and Khartoum provinces. It is present together with *A. variegatum* in Darfur, Kordofan, Baher Elgazal and Equatoria provinces (FAO, 1987; Osman, 1978; Abdalla, 2007; Gaafer, 2008).

Karrar *et al.*, (1963) found that; *H. dromedarii* was the main tick species of camels together with *Amblyomma lepidum*, *H. impeltatum*, *Rhipicephalus sanguineus sanguineus*, *Rhipicephalus praetextatus*, *H. a. excavatum*, *H. rufipes* and *H. truncatum*.

Hoogstraal (1956) found; *A. lepidum*, *A. exornatum*, *A. variegatum* and *R. decoloratus* in western Sudan and *R. annulatus* in Kordofan. He also found that the presence of *H. dromedarii*, *H. excavatum*, *H. impeltatum*, *H. impressum*, *H. marginatum*, *H. rufipes*, *H. scupense*, *R evertsi evertsi*, *R. praetextatus* and *R. sanguineus*. Although Osman *et al*. (1982) later found; different species of *Rhipicephalus*, *Amblyomma* and *Hyalomma* in Kordofan, the major tick species was *H. impeltatum.* (Osman, 1997) also argued that; the UN usual distribution of *A. lepidum* and *A. variegatum* on sheep and goats in the Nuba Mountains required further study. In a following study, cattle in Kadogli and Dilling in Kordofan State were found to be infested with *A. lepidum*, *A. variegatum*, *H. truncatum*, *H. rufipes*, *R. annulatus*, *R.*

decoloratus, R. evertsi evertsi, *R. praetextatus* and ticks of the *R. sanguineus* group (Sowar, 2002).

In Elobeid, the major tick species on horses were *H. anatolicum*, while *H. dromedarii*, *R. evertsi evertsi* and *R. sanguineus* were also present (Salim, 2008).

Salih *et al*. (2004) reported; A. *lepidum* on cattle at several localities in western Sudan, whilst *A. variegatum* was found in Elobeid and Nyala, and *H. dromedarii* in all localities sampled.

In Darfour, Osman (1978) found that; *H. rufipes*, *H. truncatum* and *R. sanguineus* were the dominant species. He also recorded; *H. turanicum*, *R.annulatus*, *Rhipicephalus cuspidatus* and *R. sulcatus* for the first time in Darfour and *R. guilhoni* and *Rhipicephalus turanicus* for the first time in the Sudan. In southern Darfur, ticks recorded on cattle were *H. truncatum*, *H. rufipes*, *H. impeltatum*. *Rhipicephalus annulatus*, *R. saguineus*, *R. longus*, *R. e. evertsi* and *R. praetextatus*.

In Gezira State, Hayati (2015) recorded; *Rhipicephalus e. evertsi* as dominant ticks, follow *H. anatolicum.* He also identifies *H. rufipes, R. sanguineus, R. decoloratus, Amblyomma lepidum, Hyalomma impeltatum* and *Hyalomma dromedarii.*

Northern Sudan, *Hyalomma dromedarii* were found; to be the predominant (89%) tick species infesting the camels. Other tick species found in very low numbers were *Hyalomma impeltatum* (7.7%), *Hyalomma anatolicum* (3.3%), *Hyalomma truncatum* (0.29%*), Hyalomma marginatum rufipes* (0.25%), *Rhipicephalus praetextatus* (0.30%) and *Rhipicephalus sanguineus* group (0.09%) **(**ElGhali and Hassan, 2009).

1.7 Economic importance of ticks:

Ticks cause great economic losses to live stock and have adverse effects on live stock in several ways (Snelson, 1975) and parasitize a Wide range of vertebrate hosts and transmits a wide variety of pathogenic agents than any other group of arthropods (Oliver, 1989).

Ticks representig the most important live stock parasitize in Africa and are found in the entire 30 million square kilometers of the African continent (Punyua, 1992).

Ticks affect live stock in three ways:

1.7.1. Direct effects:

Adhesion to the host causes irritation and direct injury of the skin, with subsequent ulceration and sometimes secondary bacterial infection. In the case of heavy infestations, causes reduction in live weight and anaemia among domestic animals, while tick bites also reduce the quality of hides and skins. Also tick can cause severe dermatitis and direct effects in cattle in terms of milk production and reduced weight gain (L´Hostis and Seegers, 2002; Peter *et al.*, 2005).

1.7.2. Toxicosis:

(Suad, 2009) wrote; that some ticks are capable of releasing toxins in the host which causes progressive, ascending, and febrile paralysis. Some time affected animals may die, the paralysis is relieved quickly if the ticks are removed.

Example is paralysis caused by feeding of *Dermacentor andersoni* and she also reported the most common tick toxicosis is probably"sweating sickness" caused by an epitheliotropic toxin produced by *Hyalomma truncatum*.

1.7.3. Transmission of diseases:

Ticks can be carriers of pathogens and transmited it from Host to host during blood sucking and cause a large variety of diseases (Suad, 2009).

The major diseases include theileriosis, babesiosis, anaplsasmosis, heartwater, East Coast fever and some viral diseases.

In addition, other diseases of lesser importance cause severe economic Losses to the live stock industry (Drummond, 1983; Bran, 1983).

The presence, dynamics and amount of parasitized help on the transmission of tick-borne diseases (Morel, 1980). Generally, ticks become infected while they are feeding on infected animals.then, the organism may be transmitted from stage to stage in the tick (an example is *Theileria parva* transmitted by *Rhipicephalus appendicuatus*), or from the female tick through the egg to the larvae an increase of several thousand times in vector potential (an example is *Babesia bovis* transmitted by *B. decoloralus*). When the next stage or generation subsequently feeds on another animal, the organism is transmitted to that animal if it is susceptible to the disease (Drummond, 1983).

Tick fever organisms, like *Anaplasma marginale*, are significant causes of cattle morbidity in Australia,USA, China and other countries (CRC-VT, 2001).

McCosker (1979) found that; acost of control to damage caused by ticks and tick-borne diseases was estimated by US$ 7 billion per year in the world.

1.8. Tick-borne diseases of importance:

The major tick-borne diseases of importance to the livestock industry can be classified according to Coetzer *et al.* (1994) and Kufmann (1996) as fallows:

1.8.1. Tick-borne Protozoan Diseases:

1. 8 .1.1. Theileriosis:

Theileriosis is an infectious, non-contagious protozoan disease transmitted by some species of hard ticks (Acari: Ixodidae). The disease affects mainly cattle and to a lesser extent sheep, goats, camels and wild ungulates (Soulsby, 1982, Mossalam *et al*., 1984).

Sheep and goats are affected by three species of *Theileria*, of which *Theileria hirci* (Dzhunkovskii and Urodshevich, 1924), named *Theileria lestoquardi nomen novum* (Morel and Uilenberg, 1981) is the most pathogenic one,the parasite causes malignant ovine theilerioses which assumes acute,sub acute or chronic forms causing high mortality rates among sheep.*Theileria ovis* and *Theileri seperata*, on the other hand, are less pathogenic and of low importance than *Theileria lestoquardi* (Soulsby,1982; Arnold and Dias, 1983; Uilenberg, 1983).

Dzhunkovskii and Urodshevich (1924**)** reported; the disease in goats in Serbia. In Sierra Leone, theileriosis has been reported in Sahelian goats with marked.

1.8.1.1.1 Theileriosis in goats:

Dzhunkovskii and Urodshevich (1924) reported; the disease in goats in Serbia.

In Sierra Leone, theileriosis has been reported in Sahelian goats with marked clinical signs (Pabs-Garnon and Foley, 1974).

In Northern Sudan,(Ed damer province), clinical signs of caprine theileriosis were not detected, but in a survey conducted by (ElHussein *et al*., 1998) among apparently healthy goats, 10 out of 82 (12.2%) goats showed piroplasms in their blood.

1.8. 1.2.Babesiosis:

(Suad,2009) wrote; infection with *Babesia* spp are characterized by haemolytic syndrome which includes high parasitaemia, continuous fever, anaemia , icterus and often haemoglobinuria which colours the urine dark brown and which gives the disease the common name of "red water". Infections associated with *B. bovis* are acute or sub acute, rapidly leading to death.

In Zebu cattle young animals, less than nine months old, are more resistant to the disease (Soulsby, 1982).

Within the European cattle, all age groups are highly susceptibl (DeVos and Potgieter, 1994). Within the host animal *Babesia* species multiply asexually forming erythrocytic forms which lead to formation of gametocyes which are picked by feeding ticks and development of the organism to infective stage within ticks depends on temperature. It is more rapid in ticks held at 28°C than those held at 25°C (De Vos and Potgieter, 1994). Piroplasms appear in the blood of the host 7-35 days after tick bite (Seifert, 1996).

The disease is differentiated from anaplasmosis by the absence of hemoglobinurea in anaplasmosis and leptospirosis infection of young animals in the case leptospirosis (Hall, 1985).

1.8.2. Tick-borne Rickestial Diseases:

1.8.2.1 Anaplasmosis:

Anaplasmosis affects domestic and wild ungulates and is wide spread through out the tropics. Anaplasmosis in cattle, caused by *Anaplasma* -species is characterized by jaundice, anaemia, and debility. It is transmitted by the tick through Tran's ovarian and stage to stage transmission (Wanduragla and Ristic, 1993).

In the Sudan *Anaplasma marginale* and *A. centrale* were diagnosed in cattle. However though, bovine anaplasmosis due to *A. marginale* was recorded in the country, the incidence of the disease in cattle was very low (1.5%) in northern Sudan (Abdallah, 1984).

A. marginale was regularly observed in the blood smear of healthy cattle in areas of the Blue and White Nile ecosystems (Jongejan *et al*., 1987). Suleiman and Elmalik (2003) wrote; prevalence of *Anaplasma* spp. infection in Khartoum State using IFA test. In 147 samples, they found 11.6% positive for the disease.

The effective Treatment is long- acting tetracyclines and imidocarbs. An attenuated vaccine of *A. centrale* was used to control the disease in Australia, Bolivia, Colombia and Argentina (Montenegro- James, 1991).

1.8.2.2. Heart water:

It is caused by the rickettsia organism *Ehrlichia ruminantium* transmitted by ticks of the genus *Amblyomma* through stage to stage transmission (Uilenberg and Camus, 1993).

(Collins *et al.,* 2003) reported; the disease is one of the most devastating livestock in sub-saharan Africa and causes considerable economic losses of domestic livestock.

Heartwater is characterized by nervous signs (continuous movement of head and limbs, ear, tongue and jaw), Muscular

tremors and circling with rigidity of the neck (Uilenberg , 1983) (Petney *et al.*, 1987).

1.8.3. Tick-borne Bacterial Diseases:

1.8.3.1. Dermatophilosis:

Dermatophilosis is worldwide distributed but more prevalent the humid, tropics and sub tropics (Zaria, 1993) and the disease affecting wide- range of animal species.

It is caused by *Dermatophilus congolensis*. Feeding of *Ambylomma vareigatum* ticks on cattle suppress immunity such that any infection with *Dermatophilus congolensis* bacteria in the skin is aggravated to cause very severe *Dermatophilosis* (Latiff and Walker, 2004).

In Kenya it has generally been found in the main semi-arid camel rearing areas (Gito, 1993). Also in Sudan the disease was reported in Butana region of eastern Sudan affecting camels (Gito *et al*, 1998).

1.8.3.2. Bovine Farcy:

The disease was believed to be caused by *Nocordia farcinica* but now *Mycobacterium farcinogenes* and *Mycobacterium senegalense* were found to be the main causitive agents (Chamoiseau, 1979).

Bovine farcy is a chronic infectious disease of cattle, in some tropical countries. It is considered as one of the most important mycobacterial infection (Timony *et al*, 1988).The disease clinically shows nodular swelling of lymphatic nodes present at the sites of the attachment of the vector tick *Amblyomma variegatum* (Blood and Radostits, 1990).the relationship between Bovine farcy and Tuberculosis (Awad and Karib, 1958) reported

that in Sudan. The disease was found to be 14.6% in condemned carcases in Malakal Abattoir (Awad and Karib, 1958).

El-Nasri (1961) noticed; the spread of the disease by 15% among Arab herds in the Nuba mountains region. Nonetheless, the disease caused losses among Bargara nomadic tribe cattle in western Sudan (Hamid, 1988, El Hussien, 2001).

Experimentally, vaccine against the Bovine farcy was conducted by Eiman, (2003) recently.

1.8. 4. Tick-borne Viral Diseases:

1.8.4.1. Nairobi sheep disease:

The disease was transmitted trans-ovarian and trans-staidly by Ixodid tick, *Rhipicephalus appendiculatus*.

Mortality rate may reach 90% in severe disease of sheep and goats.It is characterized by gastroenteritis and paralysis, which in many cases lead to death of the animal (Davies, 1997 and Kettle, 2000).

1.8.4.2. Louping ill:

It is a viral disease transmitted by the ticks of species *Ixodes ricinus.* The disease major affects sheep, but other animals can also be infected. The disease is characterized by fever, abnormal gait, convulsion, and paralysis (Blood and Radostits, 1990, Sheahan *et al*., 2002).

1.8.5. Tick Toxicosis:

The disease occurs from toxins that are secreted by several species of ticks such as *Ixodes rubicundus,R.evrtsi*, *Haemaphysalis punctata* and *Ixodes ricinus* (Doube, 1975, Blood, and Radostis, (1990)

Paralysis usually occurs during rapid engorgement by the adult females Ixodes, but there have been record of it also caused by

large numbers of Larval or nymphal ticks (Atwell, 2010).

1.9. Tick control

Control strategies of ticks depend on biology, ecology and epidemiology of ticks. It aims at reducing ticks' population and infestation levels on animals and to prevent transmission of diseases. Control of ticks and TBDs has started since the early twentieth century. Some countries succeeded in control programmes such as USA and parts of Argentina (FAO, 1984).

However, other countries have failed especially in Africa due to lack of financial resources, presence and density of host and eco-climatic factors (FAO, 1984).

Ticks can be controlled by using a combination of more than one method such as chemical acaricides, pasture spelling, natural enemies and diseases control by treatment of infected animals (Latif and Walker, 2004).

1.9.1. Host resistance

Varies according to animal breeds and number of external factors especially season, nutrition status and stress (de Castro and Newson,1993).

Animals can be classified either as high resistant and these are infested by few ticks or of low resistant which carry higher tick numbers (Latif and Pegram, 1992). Latif *et al.* (1991a) found the highly resistant cattle compared with low resistant and found that the highly resistant cattle were infested by the least successful attachments and the number fed to maturity was lower than on the low resistant. In Africa, zebu cattle (*Bos indicus*) are classified as having higher resistance than *B. taurus* (Kaiser *et al*., 1982; Rechav *et al*., 1990).

Species or one stage of the life cycle of a particular tick can be expected to be resistant to other species. Latif *et al.* (1991c) stated that survival of *R. appendiculatus* female on zebu cattle in Western Kenya was 10% on high resistance cattle, 11 – 40% on low resistant. In the Sudan Cross breed *B. taurus* X *B. indicus* carried 4.5 times more ticks, than *B.indicus* (Kenana and Butana) (Latif, 1984). He also found that ticks fully engorging on cross breed cattle weighed 422.0 mg, while those feeding on Kenana and Butana weighed 374.8 mg. The inclusion of tick- resistance through breeding programme will increase the average resistance of cattle within a herd, which can be used for tick control (Jonsson *et al*., 2000b).

1.9.2. Chemical acaricides

This method is widely used for control of ticks and prevention of TBDs (Jongejan and Uilenberg, 1994). It is applied in different ways: Dip vats are used for according to species of ticks and their density, whereas hand spraying is used for individual animals (FAO, 1984). There are other methods of acaricide application which include acaricide impregnated ears tags, tail bands, leg bands, neck bands (Drummond, 1983.; FAO,1984) and acaricide boluses (Miller *et al*., 2001). However, the sechemicals are toxic to both animal and humans and very expensive, leaveresidues in meat and milk and contaminate environment. Moreover, Resistance of ticks to these chemicals develops due to long term and in discriminate use (Bengnet *et al*., 1998). A number of tick species have developed resistance to some acaricides (FAO, 1983). In Australia, *B. microplus* developed resistance to D.D.T (Kettle, 1995).

In the Sudan, Mohamed (2002) detected development of resistance to Cepromethrine in *R. sanguineus* .

1.9.3. Biological control

Hassan *et al*. (1991, 1992) recorded that; the domestic chickens play an important role as natural tick predators in free management system.

Other predators are yellow-billed and red-billed oxpeckers (*Buphagus erythrorhyncus*) in which ticks constitute the main food components (Norval *et al*., 1991a). Similary, cattle egrets (*Ardeola ibis ibis*), guinea fowl (*Numila meleagris*), and lilac breasted roller (*Coracia caudate*) have been reported as predators (Petney and Kok, 1993).

Opportunistic predators which include rodents, spiders, toads, ants,Lizards, snakes and shrews have been described (Mwangi *et al*., 1991)

Samish and Rehacek (1999) reported that protozoasuch as *Nosema ixodis*, *Nosema parkeri* and *Nosema slovaca* were discovered from ticks, but only *N. slovaca* was found pathogenic to ticks. Fungicides such as *Metarhizium anisopliae* and *Beauveria bassiana* (Kaaya and Hassan, 2000; Perry *et al*., 2005) were found to be pathogenic to ticks. Pheromones are chemicals released by animals and influence the behaviour of other individuals of the same species (Karlson and Luscher, 1959). There are three types of pheromones which are aggregation-attachment pheromones which attract ticks to the feeding individual, while attractant sex pheromones are produced by fed females of hard ticks to attract males, and there are other various ungrouped pheromones (Leahy *et al*., 1973.; Wood *et al*., 1975.; Gothe, 1987).

Pheromones are used in tick control as mixture with other components (Norval *et al*., 1991a; Norval *et al*., 1994).

Similar trials were carried out by Norval *et al*. (1996) who used three Different acaricides with AAAP against *A. hebraeum*. They concluded that the potential of pheromones on tick control was promising.

Maranga *et al*. (2003) found that synthetic pheromones were attractive to adult *A. variegatum* while CO_2 improved attraction of *A. variegatum* to AAAP.

1.9.4. Ecologically based strategies for tick control

This strategy plays an important role in tick control and eradication programmes(Estrada-Pena, 2003). The role of this method is to decreasing chances of parasite in finding a passing host, and to interfere with development of engorged ticks. Burning of pasture, bushes, grasses, cultivation of grazing areas, use of mixed farming, removal of manure, pasture spelling, and sealing off cracks and crevices in animal enclosures largely reduce host tick contact and contribute in control of ticks (ElGhali, 1992; Hassan *et al.*, 2003).

1.9.5. Chemotherapeutical control

Antibiotics such as sulphanomides, short and long acting tetracyclines, imidocarb and gloxazone are employed in treatment of tick borne disease (FAO, 1984).

Parvaquone and buparvaquone are used as drugs of choice for theileriosis (ElHussein *et al*., 1993; Muraguri *et al*., 1999). (FAO, 1984) reported that there are many medicines used in treatment against *Babesia* spp. for example Imidocarb, Trypan Blue which are more effective against *B. bigemina* and Dimianzen

aceturate (Berenil) is widely used against *Babesia* spp.

1.10. Vaccination against ticks and Some TBDs:

Vaccination plays important role in prevention, control and reducing tick borne disease. Vaccination against ticks was carried out 60 years ago (Willadsen and Jongejan, 1999)

The first effective concealed antigen vaccine was developed against *Boophilus* spp. (Jonsson *et al*., 2000a). This vaccine successfully used to control ticks in many countries. In Australia, Tick GARD plus vaccine against *B. microplus* caused high mortality, reduction in engorgement weights and eggs production and led to decrease in tick population (Jongejan and Uilenberg, 1994).

GAVAC has been employed in Cuba, Brazil, and Mexico where the vaccine showed 55% to 100% efficacy in control of *B. microplus* in grazing cattle (Redondo *et al*., 1999). Bm86 vaccine has a significant level of cross-protection among other *Boophilus* spp. especially with *B.annulatus* giving an efficacy of about 99.9% (de La Fuente *et al*., 1999), and a good level of protection against *H. anatolicum* and *H.dromedarii* (Suliman, 2005).

CHAPTER TWO

Materials and methods

2.1 Study area:-

The study was carried out in River Nile State, Sudan .It located in the North of Khartoum State. The River Nile State is between Latitudes 22-16 º N and Longitude 30-32 º E. It is semi desert climate and temperature ranges from 47 º C in summer a maximum to 8 º C as minimum in winter. Rainfall ranges from 25mm north to 150mm south.

River Nile state include seven localities: Shendi, Al matmah, Ad- Damer which is considered the capital of the state, Atbara, Barbar, Abu hamad and Al buhira .

Animal population in River Nile State is estimated as (108538) cattle, (1411015) Sheep, (1704456) Goats, (84135) camels and (218462) Equine (Anon 2018).

2.2 Sample Collection and Identification:-

From five localities Shendi (41), El matammah (25), Ad-Damer (44), Atbara (21) and Barbar (19) Goats were selected randomly to collect tick samples.

Ticks from each predilection site were put into separate tubes containing 70% Ethanol .The tubes were labeled to indicate locality , Animal number , predilection site and sex.

The ticks were transported to Department of Tick and Tick _borne Diseases Central Veterinary Research Laboratry and Identified under dissecting microscope according to Hoogstraal (1956) and Walker *et al*. (2003).

2.3 Questionnaires:-

The questionnaire included two parts:

1- Farm information as Location, rearing system, Feeding type and hygiene.

2- Host information as sex, breed, age, colour code, tick infestation, predilection Site, and season of high infestation, tick control and methods of control.

2.4 Data Analysis:-

The collected data was interred using statistical package of social science (SPSS) and analysis risk factors by Chi-Square test, after that Regression analysis used to the associate risk factor result.

The confidence interval held at 95% and $P< 0.05$ was set for statistical Significance. The prevalence of tick was expressed as percentage by dividing the positive sample to total sample.

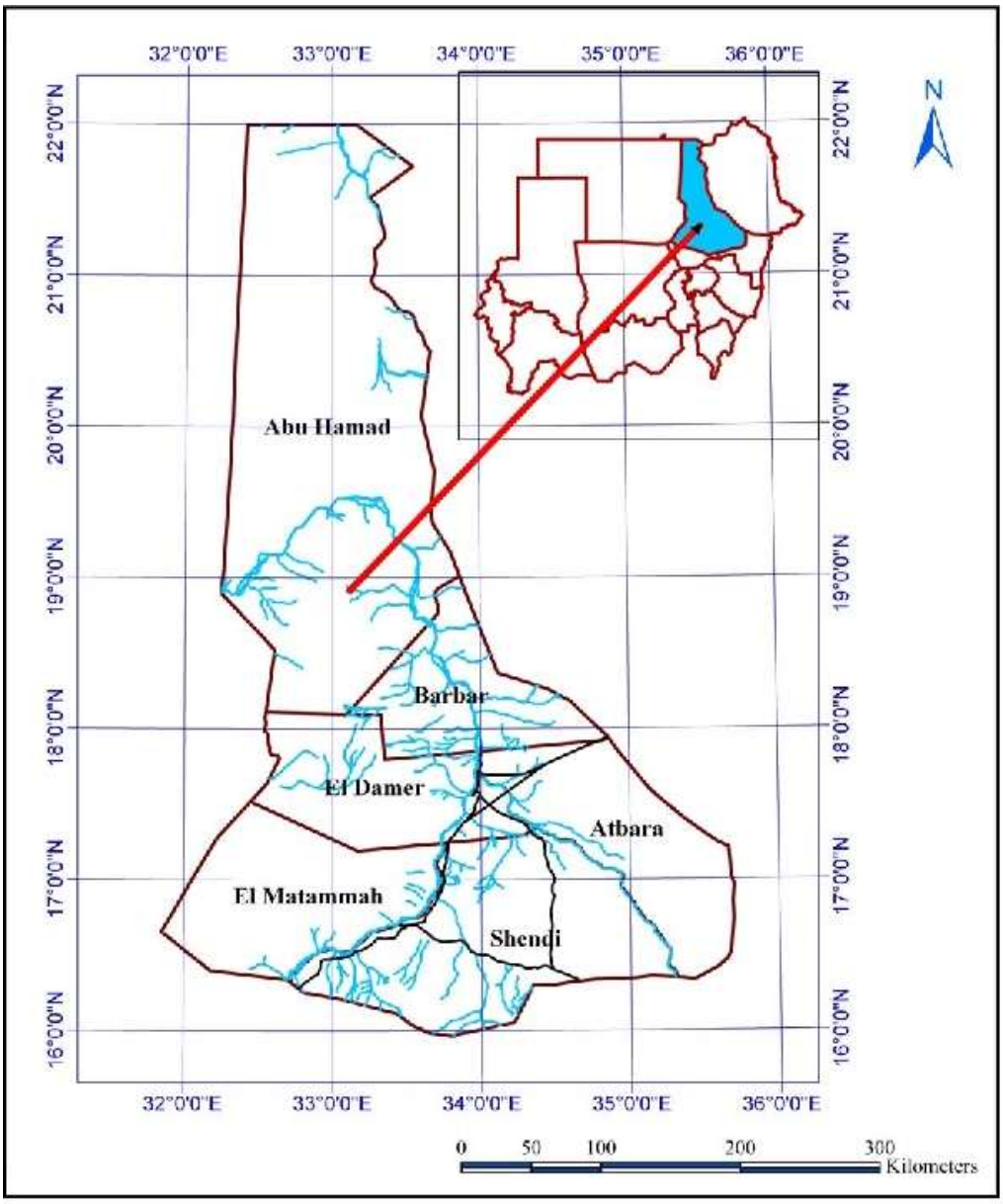

Figure 2.1: Study area-River Nile State

CHAPTER THREE

Results

3.1 Tick survey:-

Five species from two tick genera identified in survey study,

The genera included *Rhipicephalus* and *Hyalomma,*

Tick species included *Hyalomma anatolicum* , *Hyalomma Rufipes*, *Rhipicephalus evertsi* ,*Rhipicephalus sanguineus* and *Rhipicephalus praetetextatus.*

3.2 Prevalence of tick infestation:

A total Of 150 examined goat in fifth localities in River Nile State (Shendi, El matammah, Ad damer, Atbara and Barbar) Between june 2018 to December 2018 45out of 150 goat were infested with ticks and 105 out of 150 animals non infested.

Table (1) prevalence of tick infestation in goat in fifth localities:-

Locality	Infested	No infested	Prevalence%
Shendi	18	23	43.9
Elmatammah	7	18	28
Ad damer	12	32	27.4
Atbara	1	20	4.8
Barbar	7	12	36.8
Total	45	105	30

The total of (294) ticks was collected (168) males (57.14%) , (126) females (42.85%) from 150 goats. *Hyalomma anatolicum* was major tick species (44.9%) & *Hyalomma rufipes* (1.7%)

Table (2) Prevalence of tick infestation in goats according to species:

Tick species	Male%	Female%	Total%
H. anatolicum	72(24.5)	60(20.4)	132(44.9)
H. rufipes	-	5(1.7)	5(1.7)
R.eversi	73(24.82)	45(15.3)	118(40.12)
R.sanguineus	17(5.78)	12(4.08)	29(9.86)
R.praetextatus	6(2.04)	4(1.36)	10(3.4)

According to distribution of ticks species with predilection site in goats and male to female ratio the result indicated that there were more males than females in all species except in *Hyalomma rufipes* which had females only because that the male to female ratio was impossible.table (3)

Table (3) Distributions of tick's species with predilection site and male to female ratio in goat:-

Tick species	No of ticks	male	Female	Male to female ratio	Predilection sites
H .anatolicum	132	72	60	1.2:0	Ear and under tail
H. rufipes	5	-	5	-	Ear and under tail
R.eversi	118	73	45	1.6:2	Ear and under tail
R.sanguineus	29	17	12	1.4:1	Ear
R.praetextatu s	10	6	4	1.5:0	Ear and tail

The tick burden in goat in total of (150) goats there were 35 animals (23.3%) were infested by(1-8) ixodidae ticks , 7(4.6%) infested by (9-16), 2(1.3%) infested by (17-24) and 1(0.6%) were infested by(25-32) table (4)

Table (4) tick burden of goats:-

Number of ticks	Goat%
1-8	35(23.3)
9-16	7(4.6)
17-24	2(1.3)
25-32	1(0.6)

The number of males (168) large than female(126), in *H. rufipes* there were females only also the Ear had large number of ticks infested (189) and all ticks species collected from two predilection site except *R.sanguineus* collected from ear only.table (5)

Table (5) Number and sex of ticks infested in predilection site of host:-

Tick species	Ear		Tail	
	male	Female	Male	female
H.anatolicum	61	46	11	14
H. rufipes	0	3	0	2
R.eversi	27	16	46	29
R.sanguineus	17	12	0	0
R.praetextatus	4	3	2	1
Total	109	80	59	46
	189		105	

Observers mixed infections (ear-tail) the higher infested site 265(90.14%) and lower was ear 29(9.86%) table (6)

Table (6) Rate (%) of tick infestation in Predilection site of goat:

Predilection	No of tick%
Mixed (Ear-under tail)	265(90.14)
Ear	29(9.86)

3.3 Prevalence of ticks and association with risk Factor:

1/Locality:

Prevalence of ticks varied in varied state localities, the infestation rate in Shendi (43.9%), Al matamah(28%) , Ad- damer (27.2%) , Atbara (4.7%) and Berber (36.8%) in chi -square test result showed significant association between tick infestation and localities.(X2 =10.770, p –value =.029) table (7)

2/Herd size:-

Infestation rate was (30.8%), (33.3%), (16.6%) in small, medium and big herd size respectively.

The chi – square test showed there was no significant association between tick infestation and herd size (x2=1.151, p-value=.562) table (7)

3/ Housing type:-

Open type had higher infestation rate (35.8%) and the lower prevalence semi closed type (6.6%).

In chi – square test (x2=9.722, p- value = 0.02) there was significant association between housing type and tick infestation table (7)

4/Rearing system:-

One species had lower infestation rate (21.4%) and mixed species had higher rate (33.3%).

Chi – square (x2=2.041, p-value =153) Showed there was no significant association between rearing system and tick infestation (table7)

5/ Feeding type:-

Goat examined were classified according to feeding type into two groups animals feeding on roughages only had higher rate (38.2%)and other feeding on roughages and concentrates had lower infestation rate (18 %)

In chi- square result revealed that there was highly significant association between feeding type and tick infestation (x2=7.011, p-value =008)

Table (7).

6/ Animal breed:-

Goat examined were classified into three breed local had higher infested rate (36.5%) followed by foreign breed (33.3%) and finally cross breed (21.5%) in chi–square test (x2=3.925, p- value =.140) showed there was no significant association between goat breed and tick infestation table(7)

7/ Goat sex:-

Male goat had higher infested rate (31.7%) than female (25.5%)

in chi –square(x2=.560,p- value =.454) there was no significant association between goat sex and tick infestation. table (7)

8/Goat age:-

According to age factor it classified into three groups young had infestation rate(33.3%), adult(18%) and old goat (33.3%) .

Chi-square (x2=2.814 p-value =.245) there was no significant association between goat age and tick infestation table (7).

9/ Coat color:-

Result showed the highest infestation rate were white (39%) followed by brown (25.7%) and black (17.9%) and finally mixed color (0%) chi- square (x2=6.836, p- value =.077) there was no significant association between goat color coat and tick infestation table (7).

10/Tick control practices and methods:-

Tick control practiced periodically the infestation rate (19.6%), there was significant association between tick control and tick infestation (X2=5.958, p-value=.015).

(13%), (28.5%) acariside and mixed methods owners used respectively While (38%) of owners have not controlling methods.

Significant association was observed between control methods and tick infestation(x2=7.781, p-value=.020) table (7)

11/Removal of manure:-

(12.2%) owners removed manure weekly,(39.4%) removed manure monthly and other owners removed manure in various periods(38%).

In chi-square result there was highly significant association between removal of manure and tick infestation (x2=10.946, p-Value=.004) table (7)

Table (7) chi-square analysis for risk factors associated with tick infestation of (N=150) goat in River Nile state:

Risk factor	No examined	No infested%	df	x2	p-value
Locality					
Shendi	41	18(43.9)	4	10.770	.029
Matammah	25	7(28)			
Ad-damer	44	12(27.2)			
Atbara	21	1(4.7)			
Barbar	19	7 (36.8)			
Herd size					
Less than 35	120	37(30.8)	2	1.151	.562
35-70	18	6(33.3)			
More than 70	12	2(16.6)			
Housing type			1	9.722	0.02
Open	120	43(35.8)			
Semi closed	30	2(6.6)			
Rearing system			1	2.041	.153
One species	42	9(21.4)			
Mixed species	108	36(33.3)			
Feeding type			1	7.011	.008
Roughages	89	34(38.2)			
Mix	61	11(18)			
Animal breed			2	3.925	.140
Local	82	30(36.5)			
Cross	65	14(21.5)			
Foreign	3	1(33.3)			
Sex			1	.560	.454
Male	43	11(25.5)			
Female	107	34(31.7)			
Age					

Young (less than 6 month) Adult (6month-3years) Old (more than 3years)	33 111 6	6(18) 37(33.3) 2(33.3)	2	2.814	.245
Color coat White Black Brown Mixed color	39 74 35 2	7(17.9) 29(39) 9(25.7) 0(0)	3	6.836	.077
Tick control Yes No	66 84	13(19.6) 32(38)	1	5.958	.015
Control method Acaricides Both None	38 28 84	5(13) 8(28.5) 32(38)	2	7.781	.020
Removal of manure Weekly Monthly other	49 38 63	6(1.2.2) 15(39.4) 24(38)	2	10.946	.004

3.4 Regression analysis:

Regression analysis for risk factors (locality, housing type, feeding type,control,control methods and manure removal) the result showed there was no significant association between this factors and tick infestation table(8).

Table (8): Regression analysis for risk factors

Risk factor	Sig	Exp(B)	95%C.IforEXP(B)	
			Lower	Upper
Locality	.042			
Locality(1)	.948	.951	.208	4.339
Locality(2)	.297	.348	.048	2.530
Locality(3)	.016	.050	.004	.572
Locality(4)	.465	2.366	.235	23.780
Housing T(1)	. 231	.270	.032	2.301
Feed T(1)	.378	.410	.056	2.980
Control(1)	.675	1.373	.311	6.063
Methods	.984			
Methods(1)	.984	1.022	.115	9.076
Remov M	.135			
Remov M(1)	.050	5.122	.997	26.300
Remov M(2)	.073	4.271	.875	20.862

Chapter Four

Discussion

Ticks are blood sucking ecto parasites of mammals, birds and reptiles world wide, with approximately 850 species been described (Bishop et al., 2008).

Ticks and tick-borne diseases are a major cause of losses to the live stock industry and, in some cases, are a major factor limiting livestock production (Drummond et al., 1978).

In this study significant association was observed in different investigate districts and tick prevalence (x2 =10.770, p=0.029). The highest prevalence rate was observed in Shendi(43.9) followed by Berber(36.8), El-matmah(28), Ad-Damer(27.4), and Atbara(4.8) .

These variations in the prevalence rate may be attributed to the locations differences and sampling size or to agro climate condition which affect victors of population dynamics.

In the present study five species were collected from goat, predominant tick species was *Hyalomma.anatolicum*(44.9 %) Its followed by *Rh ipicephalus .evertsi* (40.12 %) and this result was agreed with result has been reported by (Mohamed .,*et al*.2004), Sajid .,et al 2008) and dis agreed with Iman (2019) she found that prevalence of *Rhipicephalus .evertsi* is higher (50.98%) than *Hyalomma.anatolicum*(4%) in goat in Khartoum State. Its followed by *Rh ipicephalus* , *R.sangiueneus* (9.86 %), *Rhipicephalus praetextatus* (3.4%) and *Hyalomma*

rufipes(1.7%) find in very low numbers, this may be due to the unfavorable climatic conditions as this tick is usually regulated or season (Hoogstraal, 1956).In the current study, the majority of examine ticks were males (57.14%) and female had minor rate (42.85%), another researcher also found that the number of tick males more than tick female (Altraifi ,2019) in Khartoum state , this is due to that males are remaining for along period on the host than females (Solomon et al.,2001) the infestation rate in all species was higher in medium herd size (33.3%) than small (30.8%) and big (16.6%) .

There was significant relation between tick prevalence and housing type (p=0.02), tick was higher in open type (35.8%) than semi closed type (6.6%).

Husbandry practices are also associated with tick exist and distribution, in this study racing type result show higher prevalence in mix farm (33.3%) than one species farm (21.4%). And this result is dis agreed with Iman (2019) result, she wrote that the higher prevalence in one species farm (87.3%) than mix farm (58%) in Khartoum state.

In the present study, significant association was observed between type of feed and ticks infestation (p= 0.008).the result showed that the tick prevalence was higher in animals feeding on roughages (38.2%) than that was feeding on mix (18%).

In the breed, higher infestation rate reported in local breed than the remainder breed. This result is compatible with Iman (2019) . The current result showed that the female animals had higher infested rate than male and this result is in agreement with (

Gedilu et al., 2014). May be because they found the same result . This results associated with male animals which were management in the farmyard for meat purpose whereas, female animals grazing on field and may be exposed to tick infestation.

The young animals were highest infested rate than adult and old. This result is infringes with previous study reported by Yakhchali and Hasanzadehzarza . They wrote that the highest rate in adult infested animal than young (Yakhchali and Hasanzadehzarza, 2004).

The effect of coat color on ticks' loads showed that animals with black coat color infested by the highest number of ticks. These finding is contradicted with Hassan (1997) and Abdalla (2007) who found that animals with white coat color usually were infested by high tick numbers , while animals with black coat color carried the lowest tick numbers and he concluded: this could be attributed to the relatively raised temperature of the host's skin environment that generated by dark coat color.

The study showed that ticks have specific preferred sites of attachment on their hosts , tail , ear and mixed sites , this is in agreement with Atif result who wrote that the most infested sites were udder ,perineum and external genitalia (Atif *et al*.,2012) this finding maybe due to the attachment of the tick depends on the sickness of the skin and the easiness for tick to engorge blood for feeding.

Significant association was found between tick prevalence and control practices (p=0.015), Also the tick prevalence was higher in the farm that did not use control measures in comparison with farms use control measures. And this result was agreed with result has been reported by Bedada (2014) found the same result in

Ethiopia. Also there was significant relation between tick prevalence and control methods used (p=0.020)

Removing of manure had Significant influence in the tick prevalence (p=0.004) because the tick has free living stage on the ground. And the result tick prevalence was reduced.

CONCLUSION

Research result revealed that the tick infestation was high prevalent in study area and had economic impact.

The study showed that the predominant tick species was *H.anatolicum*.

The analysis revealed that there was a significant association between the tick infestation and District, Housing type, feeding type, predilection site, control of tick, method of control and remove of manure.

RECOMMENDATIONS

1. Study tick Prevalence and associated risk factors in another states to accurately determine tick infesting the goat throughout the country.
2. Proper Control measures are needed to minimize tick distribution in study areas.

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QUESTIONNAIRE

Date:…….

Information of farm :

1- Owner name: Telephone: ……

2-Location: (1)Shendi … (2) Al Matama (3)Eddammar (4) Atbara (5) Barbar

3- District: ……..

4- Coordinates: ……

5- Farm number: ……..... Herd size: ……..

6- Housing type: (1) closed (2) open (3) semi closed

7-Rearing system:(1) One species (2) Mixed species

8-Feeding type:(1) roughages (2) concentrate (3) mix

Data of Animal :

1- breed :(1)Local (2) Cross (3)Foreign

2- Sex : (1)Male (2) Female

3- age:(1) young (<6Month) (2) adult (6Month-3years) (3) old (>3)years

4 - Coat color :(1)white (2)black (3) Brown (4) Other

5- Predilection site :(1) Ear (2) brisket (3) knee (4) Udder (5) Testes (6) under tail 7) Eye (8) mix (9) Not infested (

6- High tick infestation period in the year :

(1) summer (3-6) (2) autumn (7 - 5) (3) winter(10-2) (4) un known

7- Tick control practices : (1) Natural predators

(2) Acaricides Interval ……..

(3)booth Interval ……..

(4) None

8- Hygiene (removing of manure):(l) Weekly (2) Monthly

(3) Other