



Seasonal epidemiology of ticks (Acari: Ixodidae) among dairy cattle within Gezira State, Sudan

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Abstract

Ticks and tick-borne diseases (TBDs) are major constraint to livestock productivity and fitness in tropical regions. The objectives of the current study were to identify the species composition and to estimate the prevalence and seasonal distribution of tick infestation of dairy cattle in the southern Gezira state, central of Sudan as a preliminary step for more detailed ongoing research in tick-borne diseases in this region. During twelve months, species of ticks infesting dairy cattle in farms from different locations in Gezira State were determined, through winter, summer and autumn. All visible attached ticks (1236) were collected from half body of cattle heads. In each farm, monthly about 100 samples were collected according to animal sex, age (less than one year old, one to three years old and more than three years old) and breed (local breeds, cross [indigenous vs. Friesian, indigenous vs. Jearcy and indigenous vs. Jamoos]). The same animals whenever possible were used during each collection. Tick species belonging to four genera have been identified and the relative prevalence of each species was: *Rhipicephalus evertsi evertsi* was the most abundant (46.8%) from the total of the ticks followed by *Boophilus decoloratus* (14.2%), *Amblyomma lepidum* (9.20%), *Hyalomma anatolicum* (7.60%), *Hyalomma excavatum* (6.33%), *Hyalomma detritum* (5.97%), *Hyalomma impeltatum* (2.57%), *Boophilus annulatus* (2.53%), *Rhipicephalus quilhoni* (2.53%) and *Hyalomma rufipes* (1.10%). A significant ($P < 0.05$) seasonal pattern of ticks' activities were observed between animals' breeds, sex and ages. This study ascertained the presence of a broad variety of cattle tick species, with possible implications for dairy cattle production in Gezira State and most of which are of public health importance.

Keywords: ticks epidemiology, dairy cattle, Gezira state, Sudan

Introduction

In the course of initiating tick-borne viruses program in Sudan, the current investigation is part of the ongoing work. In Sudan cattle population was estimated by the Ministry of Animal Wealth at 38.3 million heads ^[1]. Viruses such as Crimean–Congo hemorrhagic fever (CCHF) was reported in cattle ^[2]. CCHF virus is a true tick-associated arbovirus. Immense knowledge was gained over the past 10 years due to the increased global interest in CCHFV as an emerging/re-emerging zoonotic pathogen ^[3]. More than twenty tick species and subspecies have been reported to be CCHF virus reservoirs/vectors. More seriously, CCHF virus survives transstadially transovarially in hard ticks such as *H. marginatum* complex and *H. anatolicum* in addition to the one-host ticks, *Boophilus annulatus*, *B. decoloratus* infesting artiodactyls especially cattle. Additionally, soft ticks such as *Ornithodoros* species, the vector of Tick-Borne Relapsing Fever (TBRF) in Arizona ^[4], was incriminated as a Alkhumura virus vector in Saudi Arabia ^[5]. Therefore, such species could be important in causing epidemics and outbreaks of human such tick-borne diseases in general and viruses in particular.

Ticks which are of great economic importance world-wide in several ways. Loss of blood, vectors for parasites such as protozoan, rickettsial and viral diseases, their bites also reduce the quality of hides ^[6, 7, 8]. Four groups of tick-borne diseases (TBDs) are of importance to the livestock production in the Sudan: theileriosis, babesiosis, anaplasmosis and heart water. Additionally, the first recognition of tick resistance to acaricides was in 1960s ^[9] however, several tick species are recently reported to be resistant ^[10]. Moreover, susceptibility of exotic breeds presents a major obstacle to the improvement of cattle production.

The direct and indirect pathogenicity of ticks as an obligate ectoparasites of vertebrates originates from blood and lymph sucking, beside the digested tissues from mammals, birds, reptiles, and amphibians and hence ticks adapted to living in harsh and diversified habitats ^[11]. In cattle, direct tick infestation could cause anaemia, stress, reduction in milk yield, weight gain hypersensitivity and toxicosis, leading also to secondary infections ^[12]. However, Ticks infect human and animal population worldwide with pathogenic viruses, bacteria, and parasites ^[13]. For instance, Tileriosis, Lyme disease, human granulocytic anaplasmosis, human babesiosis,

Rocky Mountain spotted fever, tularemia, arthritis, neurologic abnormalities. Additionally, tick-borne viruses cause significant losses in humans and in such animal production. For instance, African horse sickness virus in Sudan [14], Multiple Crimean-Congo hemorrhagic fever (CCHF) virus lineages are circulating in the Kordofan region of Sudan and were associated with outbreaks of the disease occurring during 2008–2009, when several hospital staff and patients died from the disease in a rural hospital [15]. Additionally, CCHF was isolated from ticks on imported Sudanese sheep in Saudi Arabia [16] which may also have enormous global trade implications. Moreover, Alkhurma hemorrhagic fever virus (AHFV) RNA was detected in one *Ornithodoros savignyi* tick from Saudi Arabia [17]. Humans contract the CCHF and AHFV viruses from contact with infected people, infected animals (which do not show symptoms). In general, the economic impact of various ticks species on livestock is evident [18]. In Sudan, many factors affect the distribution of ticks and tick-borne diseases. For instance, nomads' extensive animal movement, deforestation, desertification and establishment of large mechanized agricultural schemes [19]. Tick-borne disease is an extremely ignored research subjects leading to a lack of necessary scientific data. For that, the objectives of the current preliminary study were to identify the species composition and to estimate the prevalence and seasonal distribution of tick infestation of dairy cattle in the southern Gezira state, central of Sudan as a preliminary step for more detailed ongoing research in tick-borne diseases in this region.

Materials and methods

Study area

This study was carried out in Gezira state, which lines between latitudes 13° 32' – 15° 30' N, and longitudes 32° 22' – 43° 20' E (Fig. 1). The state is surrounded by four states: Khartoum state from the North side, Sinnar State in South, Gedarif State in the East and white Nile State in West, in total area of 23,373Km². The estimated annual rainfall is 272.1 millimeters, relative humidity is 70– 180% decrease in summer and winter (18-32%) and temperature is between 36.5°C–20.6°C.

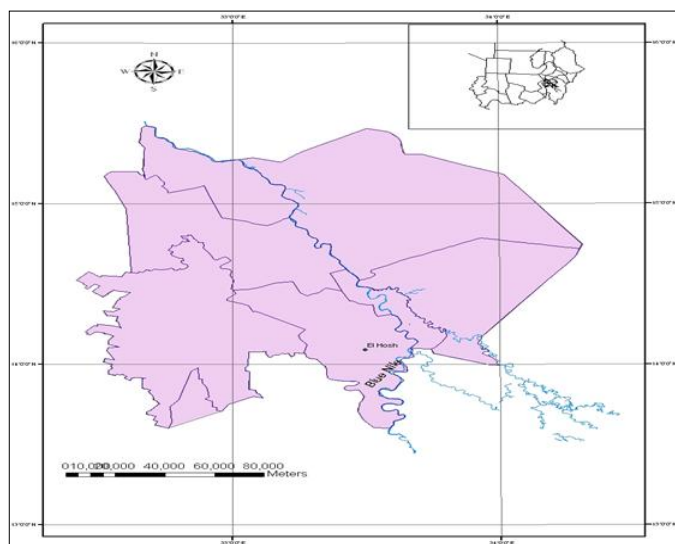


Fig 1: Gezira State indicating from where samples were collected

Tick collection and morphological identification

Collection of tick samples from (1236) Dairy cattle in Gezira State, Sudan. About 103 samples monthly for 12 months, was carried out in three seasons (winter, summer and autumn), from different breeds: local breeds, cross (indigenous vs Friezian), cross (indigenous vs Gearcy) and cross (indigenous vs Jamoos). were selected from both sex and three age groups i.e. calves less than one year old, cattle from one to three years old and cattle more than three years old cows or bulls. The same animals whenever, possible were used during each collection. All visible attached ticks were collected from half body of cattle using a pair of blunt forceps. Prior to collection, animals were cast and restrained. Collected ticks were kept in vials with 70% ethyl alcohol. Each vial was labeled indicating season, breed, age, sex, pulse and date of collection. Ticks were identified under a dissecting microscope and recorded according to sex and tick species. Identification was carried out according to the methods described [20, 21, 22].

Statistical analysis

Data collected on cattle ticks were subjected to appropriate general linear model (GLM) procedure of statistical analysis system (SAS) package. SAS was used to perform analysis of variance (ANOVA) while mean separation was performed using Ryan–Enot–Gabriel–Welsch (REGW) multiple range test (Day and Quinn 1989) [23]. Data obtained on serology and molecular biology were analysis using Chi square test.

Results

Total number and prevalence of tick species

Ten tick species were identified. The tick species were *Amblyomma lepidum*, *Boophilus annulatus*, *Boophilus decoloratus*, *Hyalomma anatolicum*, *Hyalomma detritum*, *Hyalomma excavatum*, *Hyalomma impeltatum*, *Hyalomma rufipes*, *Rhipicephalus evertsi evertsi*, *Rhipicephalus quilhoni*. The most abundant tick species was *Rhipicephalus evertsi evertsi* followed by *B. decoloratus*, *A. lepidum*, *H. anatolicum*, *H. excavatum*, *H. detritum*, *B. annulatus*, *R. quilhoni*, *H. impeltatum* and *H. rufipes*. Data on tick abundance and correlation with season, breed, sex and age of animal are given for each tick species separately as indicated below:

Amblyomma lepidum

Bulls carried significantly (0.83±0.08) more ticks than cow (0.92±0.08) (Table 2). Cattle more than three years old, carried the highest tick load (1.16±0.11) followed by cattle from one to three years old (0.87±0.15) and calves less than one year old carried the lowest (0.28±0.06) (Table 3). According to cattle breeds, the highest mean (0.82±0.08) in local breed, followed by Jamoos (0.82±0.23), Friezian (0.78±0.14) and Gearcy the lowest means (0.30±0.12) (Table 4). Seasonally the highest mean collection of this tick species was recorded in summer (1.16±0.15) followed by autumn (0.66±0.12) and the lowest means (0.61±0.07) were recorded in winter (Table 1).

Boophilus annulatus

The cows carried higher mean ticks (0.22±0.04) than bulls (0.19±0.06) (Table 2). According to ages this tick species was found with a mean of (0.25±0.06) in cattle more than three

years old, (0.31 ± 0.08) in cattle from one to three years old and (0.11 ± 0.03) in calves less than one year old (Table 3). This tick species was found in local breeds with a mean (0.24 ± 0.04) , (0.18 ± 0.05) in Friezian, (0.07 ± 0.06) in Gearcy and (0.13 ± 0.05) for Jamoos (Table 4). This tick species was found in very low numbers in autumn with the mean of (0.01 ± 0.01) , in summer (0.20 ± 0.04) and highest mean of this tick species was recorded in winter (0.33 ± 0.06) (Table 1).

Boophilus decoloratus

The cows carried significantly (1.29 ± 0.06) more ticks than bulls (0.99 ± 0.10) (Table 2). According to age this tick species was found with a mean of (1.56 ± 0.09) in cattle more than three years old, (1.02 ± 0.1) in cattle from one to three years old and (0.93 ± 0.08) in calves less than one year old (Table 3). Jamoos breeds carried highest mean ticks (1.63 ± 0.29) followed by (1.40 ± 0.13) in Friezian breeds, (1.13 ± 0.06) in local cattle breeds and the lowest means (1.05 ± 0.23) in Gearcy (Table 4). Seasonally the highest mean collections of this tick species were recorded in winter (1.28 ± 0.08) followed by summer (1.21 ± 0.10) and autumn (1.07 ± 0.01) (Table 1).

Hyalomma anatolicum

Cows higher mean ticks (0.66 ± 0.05) than bulls (0.60 ± 0.08) (Table 2). According to age, this tick species was found with a mean of (0.78 ± 0.08) in cattle more than three years old, (0.63 ± 0.07) in calves less than one years old and with a mean of (0.41 ± 0.07) in cattle from one to three years old (Table 3). The highest mean collections (0.75 ± 0.24) recorded in Gearcy breed followed by (0.66 ± 0.10) in Friezian, (0.66 ± 0.06) in local breed and the lowest means (0.33 ± 0.09) recorded in Jamoos breeds (Table 4). Seasonally, the highest mean collections of this tick species were recorded in summer (0.98 ± 0.10) followed by winter (0.57 ± 0.06) and the lowest means (0.37 ± 0.06) were recorded in autumn (Table 1).

Hyalomma detritum

Cows higher means tick (0.58 ± 0.05) than bulls (0.28 ± 0.05) (Table 2). local breeds carried highest mean ticks (0.54 ± 0.05) , followed by Friezian breeds with means (0.48 ± 0.08) , (0.42 ± 0.13) in Jamoos breeds and the lowest means (0.23 ± 0.08) recorded in Gearcy breeds. (Table 4). According to age groups this tick species was found with a mean of (0.73 ± 0.08) in cattle more than three years old, (0.38 ± 0.06) in calves less than one years old and with means of (0.30 ± 0.06) in cattle from one to three years old.(Table 3). The highest mean collection (0.74 ± 0.09) according to the seasons were recorded in summer, followed by (0.42 ± 0.07) in autumn and the lowest means (0.40 ± 0.05) were recorded in winter (Table 1).

Hyalomma excavatum

The cows carried significantly (0.61 ± 0.05) more ticks than bulls (Table 2). According to age group the highest mean of (0.79 ± 0.08) in cattle more than three years old, followed by mean of (0.36 ± 0.05) in calves less than one year old and (0.34 ± 0.06) in cattle from one to three years old. (Table 3). The highest means collection (0.59 ± 0.12) recorded in Friezian breeds, followed by means of (0.55 ± 0.05) in local breeds, (0.41 ± 0.14) in Gearcy breeds and lowest means (0.36 ± 0.09)

recorded in Jamoos breeds (Table 4). The highest means collection of this tick species (0.82 ± 0.11) according to the season were recorded in summer, followed by mean of (0.44 ± 0.06) in autumn and the lowest means (0.41 ± 0.05) were recorded in winter (Table 1).

Hyalomma impeltatum

The cows carried significantly (0.27 ± 0.03) more ticks than bulls (0.05 ± 0.01) (Table 2). The cattle more than three years old carried the highest (0.39 ± 0.05) tick load followed by calves less than one year old (0.10 ± 0.03) and cattle from one to three years old carried the lowest (0.09 ± 0.02) (Table 3). Friezian breeds carried highest mean collection (0.24 ± 0.06) tick, followed by local breeds (0.22 ± 0.03) , (0.19 ± 0.07) recorded Jamoos and the lowest means (0.14 ± 0.06) recorded in Gearcy breeds (Table 4). Seasonally, the highest mean collection of this tick species were recorded in summer (0.27 ± 0.06) , followed by winter (0.21 ± 0.03) and the lowest means were recorded in autumn (0.16 ± 0.04) (Table 1).

Hyalomma rufipes

The cows carried significantly (0.11 ± 0.02) more ticks than bulls (0.04 ± 0.02) (Table 2). According to age group this tick species was found with a means of (0.14 ± 0.02) in cattle more than three years old, (0.07 ± 0.02) in cattle from one to three years old and with the mean of (0.06 ± 0.02) in calves less than year old (3). The highest mean collection (0.21 ± 0.11) recorded in Jamoos breeds, followed by means of (0.14 ± 0.07) in Gearcy breeds, (0.09 ± 0.02) in local breeds and the lowest means (0.06 ± 0.02) recorded in Friesian breeds (Table 4). The highest means collection of this tick species (0.13 ± 0.03) according to the seasons were recorded in winter, followed by the means of (0.06 ± 0.02) in summer significantly more tick than winter and the lowest means (0.05 ± 0.02) recorded in autumn (Table 1).

Rhipicephalus evertsi evertsi

The cows carried significantly (4.33 ± 0.14) more ticks than bulls (2.92 ± 0.22) . (Table 2). According to groups, this tick species was found the highest mean of (5.12 ± 0.20) recorded in cattle more than three years old, followed by the mean of (3.57 ± 0.21) in cattle from one to three years old and the lowest mean (2.91 ± 0.17) were recorded in calves less than one year old. (Table 3). The highest means collection (5.06 ± 0.47) recorded in Jamoos breeds, followed by the means (4.07 ± 0.26) in Friesian breeds, (3.90 ± 0.14) in local breeds and the lowest mean (3.45 ± 0.54) in Gearcy breeds (Table 4). Seasonally, the highest mean collection of this tick species were recorded in summer (4.61 ± 0.23) , followed by winter (3.83 ± 0.18) and the lowest mean were recorded in autumn (3.5 ± 0.19) . In summer the carried significantly (4.61 ± 0.23) more ticks than in winter (3.83 ± 0.18) . (Table 1).

Rhipicephalus guilhoni

The cows carried higher mean ticks (0.22 ± 0.03) than bulls (0.21 ± 0.06) (Table 2). According to age group the highest means of (0.29 ± 0.05) in cattle more than three years old, followed by the mean (0.18 ± 0.05) in cattle from one to three years old and the lowest mean (0.14 ± 0.04) in calves less than one year old (Table 3). The Jamoos breeds carried highest

mean collection (0.24 ± 0.12) tick, followed by local breeds (0.23 ± 0.04), (0.18 ± 0.06) recorded in Friesian breeds and the lowest mean (0.13 ± 0.09) recorded in Gearcy (Table 4). The highest means collection of these ticks species (0.28 ± 0.05) according to seasons were recorded in winter, followed by mean of (0.19 ± 0.04) in summer and the lowest means (0.11 ± 0.04) were recorded in autumn (Table 1).

Discussion

The Sudanese natural resources, such as soil constitutes favourable conditions for tick survival and development [20]. In fact, numerous species were identified in various parts of the country [24]. Literature survey revealed that this is the first time to investigate ticks in dairy cattle in Gezira, state. Additionally, in an attempt to have an idea about the geographical distribution of ticks on cattle in the Sudan seventeen locations surveyed from Northern, Central, Eastern, Western, Blue Nile and White Nile Provinces. Out of eleven species identified, only eight species were found in the present study. These were: *Amblyomma lepidum*, *Amblyomma variegatum*, *Boophilus decoloratus*, *Hyalomma anaticum*, *Hyalomma impeltatum*, *Hyalomma marginatum*, *Hyalomma rufipes*, *Hyalomma truncatum*, *Rhipicephalus evertsi evertsi* [19, 25]. Furthermore, little information is currently available on the status of general tick infestation in Gezira state, in which a several severe outbreaks of tropical Theileriosis has occurred [26]. This fatal disease is transmitted by *H. anaticum*, which is widely prevalent in the semi-arid zone. The presence of *H. anaticum* has been confirmed in the present study with high infection rates of Theileriosis in these locations. Additionally, the population density of the *H. anaticum* (7.60%), was considerably lower than that reported for other animal species under field conditions in Sudan. This could suggest that another tick species could be involved in such transmission. For instance, in Sudan, *H. anaticum* ticks produced fatal *Theileria annulata* infection in susceptible calves in Khartoum state [27] and *Hyalomma impeltatum* and *H. dromedarii* also transmitted fatal *Theileria annulata* infection to susceptible calves [28].

On the other hand, the seasonal distribution of these species was almost similar to that previously reported in other locations in the country [25]. From the detailed information in the aforementioned results' tables, apparently there are differences in ticks' densities between seasons, animals' breeds, animals' sexes and animals' ages. The trend of seasonality of tick population by comparing the number of ticks collected during this period, there was a change numbers of ticks per head of the dairy cattle as (10.25 ± 0.39) in summer (April to June), (8.05 ± 0.29) in winter (November to March), and (6.78 ± 0.26) in autumn (July to October), in descending order of abundance. Regarding the infestation rate among different sex groups, the number of ticks per head females (9.21 ± 0.23) is superior to in males (6.96 ± 0.29) (Table 4.13). This variation may indicate that here the female animals were not kept properly in the house with good management system for dairy purpose. However, according to animal's age, calves

less than one year old scored (5.90 ± 0.24), the cattle from one to three years old (7.15 ± 0.32) and cattle more than three years old (11.21 ± 0.34) in ascending order. The chance of exposure could be higher due to outdoor movement of adults searching for food and water compared to younger animals. Moreover, mean (\pm SE) numbers of ticks per head of cattle in four different cattle breeds were: cross: indigenous vs. Jamoos (9.38 ± 0.66), cross: indigenous vs. Friesian (8.65 ± 0.43), local breed (8.37 ± 0.24), and cross: indigenous vs. Gearcy (6.68 ± 0.79) in descending order. Here more ticks burden was recorded in cross breeds compared to local cattle. This could indicate the susceptibility of cross breeds to ticks and TBDs. In contrast, the report from Ethiopia [29] revealed that the presence of tick infestation in local breeds were very high with the prevalence of 44.96% ($n = 223$), while in cross breeds and Jersey, the prevalence were 15.83% ($n = 57$), and 8.50% ($n = 30$), respectively. They explain that as the significant variation might be attributed to different management system, lack of supplementary feeding for local breeds, or lack of control measures against tick on local breeds. Furthermore, it can be assumed that it might be due to lack of interest of farmers for local breeds as well as taking more care to cross and exotic breeds than local breeds. Other factors that call for more efforts to study the tick problem in this country are the variable climatic conditions of the Sudan and the importance of the animal wealth in the national economy as reported [30].

In general, the current work points out that the present knowledge on ticks which parasitize dairy cattle in central Sudan is still fragmentary. It ascertained the presence of a broad variety of cattle tick species, most of which are of public health importance and therefore, merits high consideration. Therefore, as future work, it is crucial to practically assist the diagnosis of related TBDs in cattle in Gezira state, and to understand the ticks' zoonotic role in transmitting such diseases for people who involved in animal husbandry and to others who may acquire such diseases accidentally while being in such areas. On the other hand, effective tick control program as well as the strategic planning of cost-benefit tick control should be formulated and implemented based on the distribution pattern of ticks and factors responsible for their distribution instead of the unofficial use of chemicals and hand removal of ticks that traditionally undertaken in the area. Generally, tick-borne diseases and particularly the viruses would be major causes of morbidity and public health problem. In Sudan, as the traditional pastoral production systems, small holders and migratory producers constitute the majority of the country livestock. Despite tremendous achievements, there is a badly need to determine the levels of economic loss and human health-related issues caused by tick-borne viruses. Apparently, it could be recommended that the public health authorities should adopt effective tools such as vector studies, vector studies vaccines and antivirals/therapeutics for better public and animal health preparedness and response via promoting rural health through national prevention programs.

Table 1: Mean (±SE) numbers of ticks per head of cattle in different seasons in Gezira State

Seasons	No. of animals	<i>A. lepidum</i>	<i>R. e. evertsi</i>	<i>B. decoloratus</i>	<i>H. anatolicum</i>	<i>H. excavatum</i>	<i>H. detritium</i>	<i>H. impeltatum</i>	<i>H. rufipes</i>	<i>R. guilhoni</i>	<i>B. annaulatus</i>	Total
Winter	581	0.61±0.07b	3.83±0.18b	1.28±0.08a	0.57±0.06b	0.41±0.05b	0.40±0.05b	0.21±0.03a	0.13±0.03a	0.28±0.05a	0.33±0.06a	8.05±0.29
Summer	370	1.16±0.15a	4.61±0.23a	1.21±0.10a	0.98±0.10a	0.82±0.11a	0.74±0.09a	0.27±0.06a	0.06±0.02b	0.19±0.04a	0.20±0.04a	10.25±0.39
Autumn	286	0.66±0.12b	3.50±0.19b	1.07±0.10a	0.37±0.06 b	0.44±0.06 b	0.42±0.07b	0.16±0.04 a	0.05±0.02b	0.11±0.04b	0.01±0.01 b	6.78±0.26

Means (±SE) followed by the same letter in each column are not significantly different at 5% level based on Rayan’s Q test (REGWQ)

Table 2: Mean (±SE) numbers of ticks per head of cattle in different cattle sex in Gezira State

Sex	No. of animals	<i>A. lepidum</i>	<i>R. e. evertsi</i>	<i>B. decoloratus</i>	<i>H. anatolicum</i>	<i>H. excavatum</i>	<i>H. detritium</i>	<i>H. impeltatum</i>	<i>H. rufipes</i>	<i>R. guilhoni</i>	<i>B. annaulatus</i>	Total
Male	301	0.38±0.08 ^b	2.92±0.22 ^b	0.99±0.10 ^b	0.60±0.08 ^a	0.31±0.05 ^b	0.28±0.05 ^b	0.05±0.01 ^b	0.04±0.02 ^b	0.21±0.06 ^a	0.19±0.06 ^a	6.96±0.29
Female	936	0.92±0.08 ^a	4.33±0.14 ^a	1.29±0.06 ^a	0.66±0.05 ^a	0.61±0.05 ^a	0.58±0.05 ^a	0.27±0.03 ^a	0.11±0.02 ^a	0.22±0.03 ^a	0.22±0.04 ^a	9.21±0.23

Means (±SE) followed by the same letter in each column are not significantly different at 5% level based on Rayan’s Q test (REGWQ).

Table 3: Mean (±SE) numbers of ticks per head of cattle in different age groups(years) in Gezira State

age(year)	No. of animals	<i>A. lepidum</i>	<i>R. e. evertsi</i>	<i>B. decoloratus</i>	<i>H. anatolicum</i>	<i>H. excavatum</i>	<i>H. detritium</i>	<i>H. impeltatum</i>	<i>H. rufipes</i>	<i>R. guilhoni</i>	<i>B. annaulatus</i>	Total
≤ 1	440	0.28±0.06 ^b	2.91±0.17 ^c	0.93±0.08 ^b	0.63±0.07 ^a	0.36±0.05 ^b	0.38±0.06 ^b	0.10±0.03 ^b	0.06±0.02 ^b	0.14±0.04 ^a	0.11±0.03 ^b	5.90±0.24
≥ 1 -3	276	0.87±0.15 ^a	3.57±0.21 ^b	1.02±0.10 ^b	0.41±0.07 ^b	0.34±0.06 ^b	0.30±0.06 ^b	0.09±0.02 ^b	0.07±0.02 ^b	0.18±0.05 ^a	0.31±0.08 ^a	7.15±0.32
≥ 3	521	1.16±0.11 ^a	5.12±0.20 ^a	1.56±0.09 ^a	0.78±0.08 ^a	0.79±0.08 ^a	0.73±0.08 ^a	0.39±0.05 ^a	0.14±0.02 ^a	0.29±0.05 ^a	0.25±0.06 ^a	11.21±0.34

Means (±SE) followed by the same letter in each column are not significantly different at 5% level based on Rayan’s Q test (REGWQ).

Table 4: Mean (±SE) numbers of ticks per head of cattle in different cattle breeds in Gezira State

Breed	No. of animals	<i>A. lepidum</i>	<i>R. e. evertsi</i>	<i>B. decoloratus</i>	<i>H. anatolicum</i>	<i>H. excavatum</i>	<i>H. detritium</i>	<i>H. impeltatum</i>	<i>H. rufipes</i>	<i>R. guilhoni</i>	<i>B. annaulatus</i>	Total
Local	839	0.82±0.08 ^a	3.90±0.14 ^a	1.13±0.06 ^a	0.66±0.06 ^a	0.55±0.05 ^a	0.54±0.05 ^a	0.22±0.03 ^a	0.09±0.02 ^a	0.23±0.04 ^a	0.24±0.01 ^a	8.37±0.24
Friesian	70	0.78±0.14 ^a	4.07±0.26 ^a	1.40±0.13 ^a	0.66±0.10 ^a	0.59±0.12 ^a	0.48±0.08 ^a	0.24±0.06 ^a	0.06±0.02 ^a	0.18±0.06 ^a	0.18±0.05 ^a	8.65±0.43
Gearcy	56	0.30±0.12 ^a	3.45±0.54 ^a	1.05±0.23 ^a	0.75±0.24 ^a	0.41±0.14 ^a	0.23±0.08 ^a	0.14±0.06 ^a	0.14±0.07 ^a	0.13±0.09 ^a	0.07±0.06 ^a	6.68±0.79
Jamoos	72	0.82±0.23 ^a	5.06±0.47 ^a	1.63±0.29 ^a	0.33±0.09 ^a	0.36±0.09 ^a	0.42±0.13 ^a	0.19±0.07 ^a	0.21±0.11 ^a	0.24±0.12 ^a	0.13±0.05 ^a	9.38±0.66

Means (±SE) followed by the same letter in each column are not significantly different at 5% level based on Rayan’s Q test (REGWQ).

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