Global Veterinaria 18 (5): 343-353, 2017
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2017.343.353

Goat Farming, Challenges, Solutions and Prevalence of Blood Parasitic Diseases in Pakistan in Comparison with Others Countries of World

[1]Muhammad Jamil, [1]Noman Latif, [2]Safdar Nawaz, [1]Aftab Ahmed, [2]Yusra Harman, [2]Umer Farooq and [3]Sadam Hussain

[1]Arid Zone Research Centre (AZRC, PARC), Dera Ismail Khan-29050-Pakistan
[2]Gomal College of Veterinary Sciences, Gomal University, Dera Ismail Khan-29050-Pakistan
[3]Deparment of Zoology, Government Degree College no. 1, Dera Ismail Khan-29050-Pakistan

Abstract: Small ruminants contribute to the national economy by providing mutton and milk for human consumption and wool for industry. They are distributed throughout the country. Sheep and goats are important resources of proteins of animal origin. As the human population is increasing day by day, it is becoming increasingly important to exploit our animal resources. Small ruminants contribute largely to the livelihoods of shepherd community in developing world. Pakistan is blessed with 25 goat and 28 well defined (thin and fat tailed) sheep breeds. Parasitic diseases reduce the productivity of the small ruminants. Goats are sensitive to parasitism, which results into decreased fertility, increased susceptibility to secondary infections and ultimately death occurs. Many different types of blood parasites are found in goats which cause different types of diseases and damage to animals. All hemoparasites including *Babesia*, *Theileria*, *Anaplasma*, *Trypanosoma* and *Eperythrozoons* etc cause high mortality and morbidity due to heavy incidence. The article deals first with the importance of small ruminants, then discusses goats problems in Pakistan, their challenges and solution, blood parasites and different diseases in small ruminants and finally prevalence of blood parasitic diseases in Pakistan and all over the world are discussed.

Keys words: Pakistan · Small ruminants · Challenges · Blood parasitic diseases · Prevalence

INTRODUCTION

Goat has been aptly dubbed as "poor man's cow". They are important domestic farm animals in the world and their contribution in human nutrition is well established. Livestock production contributes substantially to the livelihoods of resource-poor rural farmers in Pakistan and plays an important role in poverty alleviation by strengthening the socio-economic conditions of goat raisers and pastoralists. Livestock sector has a major role in agriculture industry of Pakistan which contributes 11.8% in national GDP. Historically, the livestock sector in Pakistan was most important for the small holders in rural areas. Livestock play a major role in the economy of small farmers and landless poor [1]. Ticks are considered as a main agency for the transmission of hemoparasitic diseases and their prevalence may increase due to climatic changes. The major tick borne hemoparasitic diseases in ruminants are anaplasmosis, babesiosis and theileriosis [2].

In livestock industry, main objective is to improve and maintain the health and productivity of animals. Parasitic diseases lower the productivity of the affected animals. Across the country, many researches have shown that the prevalence of different parasitic diseases is high with a wide variety of parasites [3]. In Islamic countries, meat and milk of goat is considered as an important constituent of diet. Goats are sensitive to parasitism, which results into decreased fertility, increased susceptibility to secondary infections and ultimately death occurs. Many different types of blood parasites are found in goats which cause different types of diseases and damage to animals. All hemoparasites cause high mortality and morbidity due to heavy incidence [4].

Corresponding Author: Muhammad Jamil Matrah, Arid Zone Research Centre (AZRC, PARC), Dera Ismail Khan-29050-Pakistan.

The important hemoparasites include *Babesia*, *Theileria*, *Anaplasma*, *Trypanosoma* and *Eperythrozoons*, but the most important blood parasites among animals are *Babesia*, *Theileria* and *Anaplasma*. High rate of morbidity and mortality in small ruminants mainly due to theileriosis caused by *Theileria* sp. has been reported in Malaysia. Theileriosis is a tick-borne hemoparasitic disease caused by *Theileria (T.) lestoquardi* or *T. hirci*, *T. ovis* or *T. separate*. These can be diagnosed by thin and thick blood smears [5].In Pakistan, theileriosis is the major hemoparasitic disease in small ruminants. Dominant species of *Theileria* are: *T. hirci*, *T. ovis* and *T. separate*. *Theileria hirci* is transmitted by *Ixodid* ticks which cause malignant theileriosis in goats [6].In tropical and subtropical regions during summer season, theileriosis and babesiosis cause low but persistent economic losses with a high rate of prevalence in small ruminants [7].

As stated earlier, the main blood parasitic diseases are babesiosis and theileriosis. These are tick borne infections and spread by tick vectors in cattle, sheep and goat. In large ruminants, theileriosis (*T. annulata)* has been extensively studied; however, very limited information exists regarding theileriosis in small ruminants in Pakistan. Diagnosis of theileriosis is primarily through clinical symptoms and the microscopic examination of blood smears. Babesiosis and theileriosis are major economic important diseases because they cause heavy losses due to high mortality, cause decrease in production level and lowered working efficiency of affected animals in Pakistan and in other tropics and subtropics [8].

Anaplasmosis is also one of the parasitic infections. It is caused a rickettsial parasite by *Anaplasma (A.) marginale* in cattle which can be transmitted by ticks. *Anaplasma marginale* can be transmitted by machanical ways e.g. contaminated needles and biting flies. Infection in goats is usually due to *A. ovis*, which is an obligate intraerythrocytic parasite [9]. The infection is characterized by decreased appetite, weight loss, anemia, depression and fever. Tetracyclines (chlortetracycline, tetracycline and oxytetracycline) are used for the treatment of anaplasmosis. Other compounds such as imidocarb eliminate parasites from carrier animals [10]. Animals suffering from *Anaplasma* can be treated by using long acting oxytetracycline @ 20mg/kg B.W. Chlortetracycline and imidocarb @ 5mg/kg are also used.

Trypanosoma is a hemoflagellate protozoan. *Trypanosoma (T.) congolense* and *T. vivax* cause clinical trypanosomiasis in goats as well as in sheep in sub-Saharan region. Tsetse fly plays very important role in transmission of trypanosomiasis and causes high incidence of disease. *Glossina (G.) morsitans* and *G. pallidipes* are most commonly involved in transmission. *Stomoxys* sp. and *Tabanus* sp. which are blood sucking flies may also transmit the disease. The disease is characterized by parasitemia, fever (mostly intermittent) and anemia, loss of condition, reduced productivity and mortality. The disease can be treated by using quinapyramine methyl sulphate; 5mg/kg B.W, diminazene aceturate; 3.5mg/kg B.W, isometamidium; 0.5mg/kg B.W. pyrithidium bromide; 2mg/kg B.W is commonly used in goat. The disease can be controlled by prophylactic measures and by controlling vectors [11].

Eperythrozoons and *Haemobartonella* are epicellular erythrocytic bacterial parasites. These parasites cause anemia in all mammalian species like cattle and sheep. These are transmitted in mammalian species through feeding of blood arthropods including: flies, lice, fleas and ticks. These parasites are different from each other as the former one does not occur free in plasma. They are closely associated with RBC's and eperythrozoons adheres to the surface of RBC's [12].

Importance and Contribution of Goat in National Economy of Pakistan: Iqbal *et al.* [13] reviewed that the dairy potential of local dairy goat breeds along with their future scope as a dairy animal. Goats are universally called as "Poor man's cow", because of providing food in term of milk and meat therefore, supporting millions of poor and landless farmers and in this way, play a key role in reduction of global poverty especially in developing countries. About 90% goat population of the world is found in Asia. In Pakistan, 56.7 million goat populations are being raised for the purpose of milk and mutton. About 25 breeds are found in different areas of Pakistan. Goats play a vital role in reduction of poverty by producing milk, mutton and skin and hair and annually contributes about 851 thousand tones of milk, 275 thousand tones of meat/mutton, 25 million skin and 21.4 thousand tones of hair. They also contribute in foreign earning exchange and supply 2.5 % milk annually. Some important milch breeds in Pakistan includes:

Dera Din Panah (DDP), Beetal, Kamori, Naachi, Kacchan, Pateri and Damani. Former three main breeds are found in Punjab, next three breeds in Sindh and the last-named breed found in KPK, respectively. Dairy goat constitutes about five million of the total goat population and are raised both in plain and subhilly areas. The goats are kept under 4 major production systems viz: nomadic, transhumant, sedentary and household. Research has

revealed that goat population has a major and crucial role as future dairy animal in national economy as well as in the lives of small householders because goats are bred under natural field conditions, no extra labour is required for their production, these are feed along canal/river bank; roadside grazing, pastures, tree leaves, crop residues, pods etc.

Baloch *et al*. [14] carried out a study on some common ailments and area wise distribution of sheep and goat in district Bolan, Baluchistan. Sheep and goats are playing most important role in the economy of our country as they account for 400,000 tons of meat. In this way, they are contributing 43 % of total meat production in Pakistan. Sample data was collected from civil veterinary hospital in district Bolan. This data was collected through monthly progress report, routine immunization and during camping. Livestock census was also carried out for data collection. After this study, it was concluded that there are three categories of diseases affecting sheep and goat on the basis of their causal agent and these three categories of diseases were named as parasitic diseases, bacterial diseases and viral diseases. There was another category of diseases which was not covered by previously described three categories and that fourth category was named as miscellaneous diseases. Information about these diseases can be collected through a network of dispensaries and veterinary hospitals throughout the country.

Threats to Livestock Breeds: Afzal *et al*. [15] in their study on Pakistan's livestock resources, their present status and the future trends and also discuss the main issues facing by the farmers conserved with the goat production. Pakistan has the largest livestock populations which are well-adopted to the environmental conditions. In Pakistan, a total of 37 breeds of goats have been described out of which 25 breeds are well recognized. Human population mostly prefers goat meat than to sheep meat, human consumes most of the rangelands and grazing areas to other building. Factors like changing farming patterns or changing production systems and human population pressure results in the selection of those breeds that are resistant and more suitable to the changing farming systems. Lack of knowledge related to breeding policy from government leads to a greater risk of goat's breeds which are losing their identity day by day.

Tageldin *et al*. [16] investigated the losses in sheep and goat's industry due to hemoparasite *Theileria* in the sultanate of Oman. All the small ruminants were admitted to the Government Veterinary research center during the period of 1997-2001. For the purpose of study, a total of 138 flocks of goat and 178 flocks of sheep were selected. Blood samples were collected from all these animals. The clinical data was also collected along with the samples. All the selected animals were 6 months-2 years old and are different breeds of Omani sheep and goats. These collected blood samples were in a sterile vacutainers and smears were prepared from these samples, fixed in ethanol and stained with Giemsa's stain. Ticks were also collected from infected sheep and goats and preserved in ethanol. All affected sheep and goats exhibit clinical signs such as pale mucous membrane, high body temperature, recumbency, dyspnoea and death, while some animals died suddenly without showing any clinical sign. After this study, it was concluded that the tick plays very important role in transmission of hemoparasites and these ticks increase the susceptibility of animals to blood parasitic infection. It was showed that in sheep Theileriosis causes severe loss in terms of production and death of animal in Oman and it is the major threat to small ruminant farmers.

Dairy Goat Farming, its Challenges and Their Solutions: Khan *et al.* [17] in his country report on Pakistan studied about the dairy goat population, its farming, its current situation, its constraints and their solutions. Pakistan is a country where small ruminants are considered as a major source of income for poor householders. Goat farming is as a tradition and mostly for meat and milk. People mostly depends upon the goat milk because of unavailability of cow milk. Small ruminants are preferred due to their small size and high reproductive rates. Goat milk contribute about 2% to the dairy industry. Pakistan is considered as the 3rd largest country in the world in term of goat population and 4th largest country in term of goat's milk production. About 6.8 million farmers that are engaged in goat farming in tropical areas and the parasites are the major problem in those areas. In Pakistan, presence of contagious diseases including parasitic diseases is one of the major challenge. The other constraints are the inadequate food production and lack of genetically superior breeding bucks. To increase their productivity, it is necessary to effectively use the available resources, better quality vaccines and availability of experienced persons are also important in controlling of major diseases. This study reveals that in Pakistan, the goat farming is as an alternative source of income and employment for small householders. The main problems to the goat farmers includes; shortage and hygienic feed and water, poor management practices, lack of skilled and

trained persons, unavailability of superior breeds, diseases and predator results in low productivity which leads to high rate of mortality.

Major Problems Associated with Production: Khan *et al.* [18] carried out a study on fattening potential of different breeds of small ruminants (sheep and goats) under different nutritional plan in Pakistan. According to his study, small ruminants are most important source of mutton in Pakistan. In general, mostly grasses and roughages are used to feed small ruminants (sheep and goats) but to some extent supplementation of concentrates may also be given with feed which increases their fattening ability. Beetal goats and Thali sheep breeds were selected. These study animals were purchased from market and after adaptation period these animals were trialed. The duration of this study was two years. For this study, forty-two male beetal goats and twenty-one thali sheep were selected and the age of these animals were 6 months. Animals were divided into three groups randomly on the basis of feed provided. The group one was supplied with normal grazing and supplementation with concentrates, while the group two was provided with normal grazing along with 100 percent Neonatal Resuscitation Care and the third group was provided with normal grazing along with concentrate Ad libitum. In order to adjust to the different feeding plans, the animals were provided with 10 day's adaptability period. For carcass evaluation, random samples were slaughtered from each of the three groups and the carcass quality along with quantity were examined. To determine the effect of age and season the experiment was continued for about two years. Vaccination and deworming were also performed during this study period and the body weight of each and every animal was recorded before starting the experiment and on regular basis during the study. After this study, it was concluded that there is no good weight gain during 6-9 months of age, the increase in weight start after 9 month of age and onward. In winter, the feedlot activity is more advantageous and profitable rather than in summer season, because in summer there is no weight gain due to heat stress so the animals should be provided with less concentrates during summer.

Blood Parasites Prevalence in Different Countries

Blood Parasites Prevalence in Nigeria: Ademola *et al*. [19] conducted a study to determine the blood parasites of animals which reduce the productivity and leads to high mortality. The study was conducted in Ibadan at the Bodija Municipal Abaattoir, Nigeria. Blood samples were collected from 240 ruminants including cattle, sheep and goats and 142 pigs between May and October, 2012. Five ml blood samples were collected directly from jugular vein in bottles containing ethylene diaminetetra acetic acid (EDTA) and dispatched to the parasitology laboratory, Faculty of Veterinary Medicine, University of Ibadan. Thin blood smears were prepared, air-dried, fixed in methanol, stained with Giemsa's stain and rinsed in buffered water. Stained smears were examined under microscope. The results indicated that out of 240 ruminant blood samples, 12 were positive for different hemoparasites (anaplasmosis, babesiosis and theileriosis) and the overall prevalence was 5%. The infection increased with the increase in age and female were more susceptible than males.

Blood Parasites Prevalence in Saudi Arabia: EL-Metenawy *et al.* [20] investigated the prevalence of blood parasites of goat in different seasons (autumn, winter, summer and spring) at Al-Qassim region, Saudia Arabia. For this purpose, a survey was conducted for a period of three years (1994-1997). A total of 132 goats were selected for the collection of blood samples. The results showed that the overall prevalence of *Theileria hirci* was higher in sheep than in goats. The infection rate was double in sheep than in goat during the autumn season while the infection rate was equal during the winter and summer but during spring, parasitic incidence reaches at the highest level.

Blood Parasites Prevalence in Sudan: Basheir *et al*. [21] conducted a survey for blood parasites in South Kordofan State, Sudan. Blood samples were collected from 134 goats. The seasons were dry, cold and rainy and the time was also different for blood sample collection. Five (3.70%) out of 134 goats (4 were positive for Babesia and 1 for Theileria) were positive. In hot dry season, theileriosis was at the highest prevalence while in rainy season babesiosis and trypanosomiasis prevalence was at the peak. It was also concluded that in cold dry season, prevalence was minimum for all blood parasites.

Blood parasites prevalence in Northern Nigeria: Jatau *et al*. [22] determined the prevalence of hemoparasitism of goats and also the effect of these parasites on blood cells. The study was conducted at abattoir in Kano, Northern Nigeria. A total of 97 blood samples were collected from Kano brown goats between the months of July and September, 2009. Immediately after slaughtering, five ml of blood was collected from jugular vein and poured into the

bottle containing EDTA, then proper labelling was done and transferred to the laboratory on ice. The blood samples were examined immediately using wet blood film and thin blood film were prepared by Giemsa's staining. Hemocrit Centrifugation Technique was used for identification of blood parasites. The prevalence of *Anaplasma ovis* 11 (11.34%), *Babesia ovis* 2 (2.06%) and *Theileria ovis* 4 (4.12%) was recorded.

Blood Parasites Prevalence in European Countries: Stuen *et al*. [23] conducted a study to investigate the hemoparasites in small ruminants, their challenges and clinical relevance of these parasites in European countries. There are several types of blood parasites which cause infection in small ruminants in European countries and all are transmitted by ticks. Population of these ticks may be influenced by climatic change as they increased during summer season and not commonly found in winter season. Major tick transmitted hemoparasites includes; *Babesia ovis, Babesia motasi, Anaplasma* ovis, *Anaplasma mesaeterum*and *Theileriaovis.* Most important tick borne parasitic disease of sheep and goats is Babesiosis, widely distributed in tropical and subtropical areas of different countries. *Babesia (B.)* species includes *B. motasi, B. ovis* and *B. bigmena.* Ticks belonging to family *Rhipicephalus turanicus, Rhipicephalus bursa* and *Rhipicephalus sanguineus* are major cause of *babesia* transmission. Among these species, *Babesia motasi*is more pathogenic for goats than *Babesia ovis*. Babesiosiscan be treated by diminazine aceturate. *Anaplasma ovis* and *Anaplasma mesaeterum,* both are obligate parasites of RBCs of sheep and goats. Oxytetracycline was used as a treatment of Anaplasmosisin infected sheep and goats. The third most important blood parasitic disease of sheep and goat is Theileriosis. There are several types of *Theileria* (*T.*) infecting sheep and goats in European countries: some of them are *T. ovis, T. lestoquardi, T. separate* and *T. recondite.* The ticks involved in the transmission of *Theileria* are *Rhipicephalus bursa* and *Hyaloma punctata.* Parvaquone and buparvaquone may be used for the treatment of Theileriosis. Halofuginone can also be used in heavy doses for the treatment of Theileriosis in sheep and goat. The fourth one major tick borne hemoparasite is Eperythrozoons. These are rickettsial parasites found on the surface of red blood cells and also named as *Mycoplasma* and *Candidatus mycoplasma.* In small ruminants, *Eperythrozoon* infection can be treated by using tetracycline, neoarsphenamine and by using antimosan drugs. After this study, it was concluded that in European countries tick borne blood parasites are highly distributed but their exact prevalence rate and surveillance is unknown. Ticks can be controlled by good management and by using vaccination and control of tick results in a noticeable decrease in population of tick borne hemoparasites.

Blood parasites prevalence in KPK, Pakistan: Talat *et al*. [24] investigated the blood parasites of different animals including sheep, goat, cattle, rabbit, jackal, rat, mice, guinea pig and cat. The blood samples were collected from different animals in different areas of KPK in June and July 2003. In this study, 209 blood samples of sheep and goats were examined. A total of 25 blood samples were infected with *Anaplasma ovis.* The infection rate of sheep with *Anaplasma ovis* was 13.2% and in goats it was 9.59%. It was concluded that *Anaplasma ovis* is highly pathogenic parasite which cause severe destruction of RBCs.

Blood Parasites Prevalence in Turkey: Altay *et al*. [25] conducted a study to identify the diversity and distribution of *Theileria* and *Babesia* sp. in small ruminants in Turkey. A total of 920 animals (sheep n= 705 and goats n= 215) were selected for sampling in ten different provinces of Turkey during June 2005 to October 2006. All the selected animals were thoroughly examined and all were healthy animals. DNA was extracted from blood samples and specific primers (18s rRNA gene and RLB) were used for *Theileria* and *Babesia* for amplification. The results showed that the parasitemia rate was 0.01% to 1%. Total prevalence rate of *Theileria* and *Babesia* was 38.36%. While separately, it was 34.56% for *Theileria ovis* and 5.43% for *Babesia ovis.*

Blood Parasites Prevalence and Their Comparison in Six Different Regions of Saudia Arabia: Al-Khalifa *et al*. [26] compared the blood parasites of goat from six different regions of Saudi Arabia which included Tabouk, Asir, Riyadh, Jazan, Eastern and Northern Frontiers during the years from 1990 and 1991. A total of 454 blood samples were collected from ear vein of goat. The conclusion of this study was that there was a fairly high infection of *Theileria hirci, Theileria ovis* and *Eperthrozoon ovis* in all six regions. The infection rate varies (Tabouk 6%, Asir 13.0%, Riyadh 6.9%, Jazan 12.3, Eastern 9.3% and in Northern Frontiers 5.0%).

Babesia Prevalence in Iraq: Sulaiman *et al*. [27] investigated the babesiosis in Iraqi goats. A total of 175 goats were selected and these were examined in Teaching

Veterinary Hospital of Mosul University. Clinical examination of all suspected goats was done carefully. Blood serum samples were also tested to determine biochemical changes. The percentage of *Babesia* sp. including *B. ovis, B. taylori, B. foliate* and *B. motasi* in twenty-seven infected goats was 15.42%.

Babesia Prevalence in Lahore: Ijaz *et al*. [28] reported the prevalence of babesiosis in goat in Lahore and its peri-urban area. Atotal of 377 blood samples from the goats of all age group and both sexes were collected which were brought at outdoor teaching hospital of University of Veterinary and Animal Sciences, Lahore and also from the Govt. and private hospitals, during August to November, 2010. For hematological examination, 5ml of blood was collected directly from the jugular vein and poured into EDTA tubes @ 1mg/ml of blood. The data recorded on the basis of hematological examination revealed babesiosis prevalence was 13.53%. Imidocarb dipropionate along with oxytetracycline was the most effective therapy against babesiosis in goats.

Investigation of *Babesia* in North Iran: Mousa *et al*. [29] Conducted a study to investigate the babesia specie in blood of sheep and goats in north of Iran. For this purpose, they selected a total of 220 animals (160 sheep and 60 goats) from 22 flocks in different regions. In addition, the standard PCR and semi nested PCR was performed to identify the species of *Theileria* and *Babesia*. The results suggested that babesiosis due to *Babesia ovis* is a common disease of sheep in Northern Iran.

Babesia Prevalence in Greece: Theodoropoulos *et al.* [30] conducted a study on small ruminants to determine the prevalence of Babesiasp. by PCR. A total of 32 blood samples was collected from the goats randomly selected herds located in the important livestock production regions of Thessaly and Epirus, Greece during August-October of 2002. Data on the characteristics of animals as species, gender, age, tick burden and the presence of hemoglobinuria kept in mind when blood samples were collected. The results revealed that the blood samples collected during the summer and autumn season when the prevalence of babesiosis is usually seen higher and through PCR it was confirmed that the percentage of positive *Babesia ovis* in goats was found to be 4.14%.

Babesia Infection in Small Ruminants in North-east of Iran: Razmi *et al.* [31] conducted a study to investigate the prevalence babesiosis in small ruminants in Mashhad area, capital city of Khorasan province which is situated in north-east of Iran from year 1998 to 2000. A total of 385 goats from 77 flocks were clinically examined for the presence of Babesiasp. in blood smears and any tick species on the body of the animals. This study revealed that 14.8% of goat were infected with *Babesia*. The prevalence of *Babesia ovis* and *Babesia motasi* in goats were 0.5% and 0.5%, respectively. Double (mixed) infections occurred in 1 goat (0.25%). The prevalence of *Babesia* infection between male and female and between different age groups of goats were statistically non-significant. Monthly prevalence of *Babesia* in goats was not significant. The clinical signs of babesiosis were observed about 6.8% of infected goats. The percentage of infected goat was significantly less.

Babesia Motasi in Small Ruminants in China: Niu *et al*. [32] conducted a study to investigate the genetic diversity and molecular characterization of *Babesia motasi* in small ruminants from china. A total of 1081 samples were collected from sheep n=753 and goats n=328 from 11 different provinces of China during March 2009 to August 2015. Blood samples were collected from ear vein and placed in a tube containing EDTA. The DNA was extracted from these blood samples and amplification of genome was done by using Nested PCR and PCR primers were designed for specific genes. A product from second PCR showed positive results for *Babesia motasi* infection and a total of 139 blood samples showed positive results for both sheep and goats while different ticks were identified in this study. So, it was concluded that ticks play an important role in transmission of *Babesia motasi* infection in sheep and goats in China.

Theileriosis Prevalence in Different Areas of Pakistan
Theileriosis in Small Ruminants in Lahore: Naz *et al.* [33] investigated the prevalence of theileriosis in small ruminants in Lahore, Pakistan. A total of 256 goats were selected from herd located at different areas in and around the Lahore and also those animals which were brought for treatment to the Veterinary Diseased Investigation section, Veterinary Research Institute, Lahore, Pakistan. Blood smears were made and stained with Giemsa's stain and examined under microscope for the presence of piroplasms in the erythrocytes of the infected goats. Their results showed that the number of positive animals was 21 and their prevalence was found to be 8.2% in goats during the month November, 2005 to October, 2006. The prevalence of *Theileria* sp. was found to be different in different seasons of the year. High prevalence during hot season than in winter, low prevalence rate in kids than

adults and males were more susceptible than females. The most important was that the tick's infestation was directly related to the hemoparasites.

Theileriosis Prevalence in Attock and Islamabad: Irshad *et al*. [34] conducted a study to determine the prevalence of theileriosis and tick infection in sheep and goats. To this end, a study was carried out at two different farms which are located in Potohar region named as BLPRI Kherimurat, District Attock and NARC, Islamabad. The animals were examined during fall season (October and November, 2009) at NARC, Islamabad. However, at BLPRI the animal was examined during February to July, 2009. A total of 662 animals were selected and samples were collected and preserved in 70% alcohol after staining and KOH treatment to observe the tick infestation morphologically under the stereomicroscope. A total of animals 279 (sheep n=95; goats n=184) were selected for blood samples. The blood was collected using EDTA containing sterile tube from jugular vein and slides were prepared through Giemsa's stain and examined under microscope for the identification of theileria. These results suggested that the propagation and multiplication of ticks increases in hot and humid seasons and the prevalence of Piroplasmswas 3.8% (7/184) in goats.

Clinical and Hematological Studies of Theileriosis in Goats in Middle Iraq: Salman *et al.* [35] reported the clinical signs and hematological studies of theileriosis in local breed of goats in Baghdad, Diala and Al-Anbar, in middle Iraq. A total of 230 goats were sampled, age ranges from 1-5 years and from both the sexes were examined randomly during the time 20 June to 25 December, 2011. Careful clinical examination was done as body temperature, pulse rate, respiratory rate, lymph nodes, mucus membrane and ticks presence was carried out. Blood sample was collected from jugular vein for slides preparation and for hematological examination, includes; RBC, Hb, PCV, MCV, MCHC, TLC and DLC. Thin blood smears were prepared, air-dried, fixed in methanol, stained with Giemsa's stain and then examined microscopically. This study results in confirmation of theileriosis infection depending upon the clinical signs, microscopically examination and change in hematological parameters. An overall record occurs in 150 goats then select 50 goats as healthy group which appeared normal signs (Temperature, Pulse, Respiration) with the normal range and about 100 number of goats were recorded infected and appeared the signs of increased in body temperature, pulse rate, respiratory rate, enlargement of lymph nodes, pale yellow mucous membrane, anemia and weakness. The hematological parameters results showed that there was significant ($P< 0.01$) decreased in RBC, Hb, PCV and TLCdecreased significant ($P< 0.05$). High level of parasitemia and presence of Koch blue bodies in lymphocytes was showed in all cases of theileriosis when blood samples were examined. There was a high rate of infection in summer season mostly in August with increasing climatic temperature and humidity as compared to other seasons especially in winter season the prevalence was mostly non-significant.

Incidence rate of *Theileria* infection in small ruminants in China: Youquan *et al*. [36] studied the prevalence of Theileria infection in goats in central China. A total of 156 goats blood samples were collected randomly from the five different areas of Hubei and Henan Provinces, central China. Thin blood smears were prepared, air-dried, fixed in methanol, stained with 10% Giemsa's solution and then examined microscopically. Piroplasm infections was observed microscopically in blood smear samples and most presented as rod, needle-like, pear shaped, or spherical forms. The results from this study showed that the incidence rate of theileriosis in the test animals ranged from 10% to 15% in the five regions.

Theileria Infection in Domestic Ruminants in Northern Ethiopia: Gebrekidan *et al*. [37] investigated the Theileriaand Babesia infection in domestic ruminants (cattle, sheep and goats) in northern Ethiopiasub-Saharan, Africa in the year 2013. A total of 265 goats (108 females and 29 males) were included in the study. Blood samples were taken from the jugular vein and collected into EDTA tubes, these blood samples were transported to the Hebrew university of Jerusalem, school of veterinary medicine, in Israel in a cold pack and stored at -80 degrees Celsius. Thin blood smears were prepared, air-dried, fixed with methanol and examined under microscope. Through the study it was founded that the 2% goats were positive for different *Theileria*(*T.*) sp. as *T. ovis* and *T. separate*. The infection rate was 1.5% (4/265) and 0.4% (1/265) for *T. ovis* and *T. separate*, respectively. Furthermore, gender and age were not associated with the positivity for Theileria infection.

Comparison of *Theileria ovis* in Punjab and KPK in Pakistan: Durrani *et al.* [38] carried out a study to compare the presence of *Theileria ovis* by PCR amplification in sheep and goats from Punjab and KPK, provinces of Pakistan. For this purpose, a total of 210 animals (sheep n= 99 and goats n= 111) were selected from four different areas of Punjab (Layyah, Multan,

D.G.Khan and Rahim Yar Khan) and one area of KPK (Kohat). The selected animals were clinically healthy and overall examination of animals was done. For data collection regarding age, specie, breed, sex, vaccination status, presence or absence of ticks, any previous medication for theileriosis and any outbreak at herd, a questionnaire was prepared and was filled at the spot by investigator. The blood samples were collected from jugular vein and collected into a tube containing EDTA. Thin blood smears were prepared, air dried, fixed into methanol and stained with Giemsa's stain. After staining, these smears were examined under microscope. PCR was done and for this purpose DNA suspension of five micro liters was used as a template in PCR and after 35 cycles PCR amplification was obtained in thermocycler. After this study it was shown that by PCR a total of 12 samples were positive for theileria, while by blood film examination only two samples were show positive results. So, it was concluded that PCR is a reliable method for detection of theileria rather than blood films while the prevalence rate of theileria in Punjab was lower than KPK and it was also shown that ticks are the major risk factor for prevalence of Theileriasp.in sheep and goats.

Molecular detection of *Theileria lestoquard* from five districts of Southern Punjab: Fatima *et al.* [39] conducted a study to investigate the prevalence and molecular detection of *Theileria lestoquardi* by PCR amplification in apparently healthy small ruminants from five districts (Dera Ghazi Khan, Multan, Layyah, Bahawalnagar and Muzaffargarh) of Southern Punjab. A total of 115 animals (sheep n=49 and goats n=66) were selected for sample collection and a questionnaire was prepared to collect the data about animal age, sex, breed, feed and about the climatic conditions of the area where the selected animals were lived. The blood samples were randomly collected and before collection the animals were thoroughly examined for the health status as no diseased animal were selected intentionally. The blood samples were collected from jugular vein and were placed in tubes containing EDTA. PCR was performed in thermo cycler for the amplification and for this purpose specific primers were used. 1.5% agarose gel was used to visualize the PCR products and the samples were stored at 4°C. This study showed that the samples obtained from sheep in district Multan were positive (3.47%) while goats were negative while all the samples collected from remaining four district of Punjab were negative by PCR. It was concluded that there is no involvement of age, sex and breed of animal in spread of disease but presence of ticks is an important risk factor for transmission of *Theileria lestoquardi.*

Anaplasmosis Prevalence in Different Countries

Anaplasmosis Prevalence in Lahore: Ali *et al*. [40] studied the prevalence of anaplasmosis in clinically affected goats near the River Ravi, Lahore. Blood samples were collected from one hundred and fifty goats from different fields, public and private hospitals. Thin blood smears were prepared and examined in the laboratory of Medicine Department, University of Veterinary and Animal Sciences, Lahore. For hematological examination, 46 blood samples were directly collected from jugular vein. The results showed that overall forty-six (30.67%) of 150 goats were positive for anaplasmosis.

Anaplasmosis Prevalence in South Mediterranean: Said *et al***.** [41] demonstrated the prevalence of *Anaplasma bovis* in small ruminants in the South Mediterranean. A total of 303 healthy goats, from 16 randomly selected flocks located in 5 localities from two bioclimatic areas in Tunisia were sampled in May 2011 and from May to September 2013. For each animal, blood sample was collected from the jugular vein and placed in a vacutainer. The blood parasites were investigated by nested polymerase chain reaction (nPCR) assay. This study results that the infection rate of *Anaplasma bovis* in goats were 23.8% and the goats that were located in a sub-humid area were statistically more infected than those located in a humid area.

Haematological Study on Common Blood Parasites in Mosul Area of Iraq: Alsaad *et al*. [42] investigated the common blood parasites in native goat in mosul area of Iraq. A total of 97 native goats was selected, their age ranges from 2-4 years, from both sexes. Animals were examined clinically, out of 97 goats 15 were served as control and other 82 as naturally infected blood parasites. Goats were divided into three groups according to hematological tests. The group of 30 goats were infected with *Babesia motasi*, 24 were infected with *Anaplasmaovis* and 28 were infected with *Theileriahirci* (*T. lestoquadri*). There hematological results indicate that the blood parasitic infection affected blood parameters as total red blood cells, haemoglobin concentration, packed cell volume significantly decreased, beside the significant increase in the erythrocytes sedimentation rate and anemia of different types were also recorded depending on the type of infection. Total platelets count was significantly decreased and this results that infection with *Babesia motasi* has an adverse effect on blood clotting indices in comparison with other blood parasitic infections.

Trypanosoma Vivax Infectivity to Nubian Goats: Nadia *et al*. [43] investigated the hematological profiles and infectivity of *Trypanosoma* (*T*.) *vivax* (isolated from an area outside tsetse zone) to Nubian goats. Twenty male goats aged 9-12 months were used out of which fifteen animals were experimentally infected with *T. vivax* stock, while five animals served as uninfected control. A total of 253 blood samples was collected from the jugular and ear veins. Trypanosomes were detected by using different standard parasitological methods viz., wet blood smears (124 from jugular vein and 129 from ear vein), thin (124 from jugular vein and 129 from ear vein) and thick blood smears (129 from jugular vein and 133 from ear vein) stained with 10% Giemsa's stain, Hematocrit Centrifugation Technique (HCT; 141 from jugular vein and 141 from ear vein) and Buffy Coat Technique (BCT; 135 from jugular vein and 140 from ear vein). These techniques revealed positive results with ratios of 47.15, 47.15, 49.05, 53.61 and 51.33%, respectively for samples taken from the jugular vein, while ratios of 49.05, 49.05, 50.57, 53.61 and 53.23%, respectively were obtained for samples of the ear vein. The results of this study showed that infected animals suffered very high levels of parasitemia and anemia.

Anaplasma Ovis Infection in Iran: Hamedani *et al*. [44] conducted a study to measure the hematological parameters in goats naturally infected with *Anaplasmaovis* in North (Gonbad) and Northest (Mashhad), Iran from May to September 2008. A total of 193 blood samples was collected from goats (170 females and 23 males) from jugular vein and collected in vacutainer tubes containing EDTA, thin blood smears were prepared, stained and then examined under microscope using oil emulsion. DNA was extracted and PCR analyses results in presence of *Anaplasmaovis* inclusion bodies in thin blood smears. Hematological analyses were conducted out to calculate the RBC, WBC, Hb, HCT, MCVs, MCHs and MCHCs.Forty-seven blood samples from infected and thirty-seven samples from uninfected group, hematological profile results in significant decrease in RBC, HCT and Hb concentration and the other parameters like WBC, MCV, MCH, lymphocytes, eosinophils and monocytes in the infected goats were also lowered but neutrophils were higher than in the uninfected goats. The results from this study revealed that *Anaplasmaovis* infection in goats were associated with marked changes in hematological parameters. These hematological parameters were considered asa useful tool for diagnosis, prognosis and evaluation of the treatment for *Anaplasma ovis*.

Incidence and Prevalence of Tick-borne Blood Parasites Including Anaplasma, *Babesia* and *Eperythrozoon* Sp. In Domesticated Animals: Sakyi *et al*. [45] conducted a study on the incidence and prevalence of tick-borne hemoparasites in domesticated ruminants in Greater Accra region of Ghana from May, 1994 to December, 1996. A total of 428 caprine blood samples was collected from jugular vein into vacutainer tubes containing EDTA as anticoagulant. Thin blood samples were prepared from each blood sample, air-dried, fixed in methanol, stained in Giemsa's stain and rinsed with distilled water, then examined under light microscope (oil immersion). The results showed from this study that only the *Anaplasma ovis*and *Theileriahirci* (*T. lestoquardi*) was the tick-borne hemoparasitesfound in kid'sup to 3 months of agewas present throughout the Ghana than the other species (Trypanosomes, Babesia and Eperythrozoon). A little prevalence of *Trypanosome* was found in the adult goats. Lowered packed cell volume (PCV) was measured in goats, with very little variation between age groups and the prevalence of Eperythrozoon was found mainly in bovine than that in caprine sp.

CONCLUSION

From the previous study, it was concluded that blood parasites are prevalent in winter season but their prevalence rate is not so much higher. The hemoparasites mainly *Babesia motasi, Babesia ovis, Theileria hirci, Anaplasma ovis*, Trypanosomes, Haemobartonella and Eperythrozoons that severe infection in goats only in summer season as compared in winter season. Hemoparasites can infect goats of all ages. Moreover, female goats are usually more prone to disease than the males. The prevalence of hemoparasites has wide variation throughout the world. Such variation may be attributed to a variety of factors such as difference in the prevalence of mosquitoes, ticks, flies, susceptibility of caprines for acquiring hemoparasitic infection, geoclimatic conditions, (dry, cold and rainy) and hygienic conditions, level of education and availability of highly sensitive diagnostic technique such as PCR, DNA PROBES, ELISA and seronegative test.

REFERENCES

1. Gadahi, J.A., M.J. Arshad, Q. Ali, S.B. Javaid and S.I. Shah, 2009. Prevalence ofgastrointestinal parasites of sheep and goats in and around Rawalpindi and Islamabad, Pakistan. Vet. World, 2: 51-53.

2. Demessie, Y. and S. Derso, 2015. Tick borne hemoparasitic diseases of ruminants. Adv. Bio. Res, 9: 210-224.
3. Iqbal, Z., M.N. Khan, M.A. Karkar and A. Jabbar, 2004. A critical analysis of parasiticresearch on some domesticated animals of Pakistan. J. App. Em. Sci., 1: 1-14.
4. Fadraga, M., C.O. Cordoves and T. Puentes, 1991. Circulation of antibiotics tohaemoparasites in cattle (*Bos Taurus*) of high genetic value in Cuba. Revista Cubana de Ciencias Veterinarias, 22: 249-255.
5. Zainalabidin, F.A., N. Raimy, M.H. Yaacob, A. Musbah, P. Bathmanaban, E.A. Ismail, Z.C. Mamat and Z. Zahari, M.I. Ismail and C. Panchadcharam, 2015. The Prevalence ofparasitic infestation of small ruminant's farms in Perak, Malaysia. Tropical Life Sci. Res., 26: 1-8.
6. Naz, S., A. Maqbool, S. Ahmad, K. Ashraf, N. Ahmad, K. Saeed, M. Latif, J. Iqbal, Z. Ali, K. Shafi and I.A. Nagra, 2012. Prevalence of Theileriosis in small ruminants in Lahore, Pak. J. Vet. Anim. Sci, 2: 16-20.
7. Rjeibi, M.R., M. Gharbi, M. Mhadhbi, W. Mabrouk, B. Ayari, I. Nasfi, M. Jedidi, L. Sassi, M. Rekik and M.A. Darghouth, 2014. Prevalence of piroplasm in small ruminants in North-West Tunisia and the first genetic characterization of *Babesia ovis* in Africa. Parasite J. Org., pp: 21-23.
8. EL-Metenawy, T.M., 1999. Blood parasites of sheep and goat at AL-Qassim Region,Saudia Arabia. J. Pak. Vet., 19: 43-45.
9. Jabbar, A., T. Abbas, Z. Sandhu, H.A. Saddiqi, M.F. Qammar and R.B. Gasser, 2015. Tickborne diseases of bovines in Pakistan: major scope of future research and improvedcontrol. J. Parasit. Vector, 8: 283.
10. Ali, A., M. Ijaz, A.Z. Durrani, M.M. Ali, K. Mehmood and A.J. Sabir, 2014. Prevalenceand chemotherapy of Anaplasmosis in clinically affected small ruminants in the River Ravi region, Lahore. Pak. J. Zool., 46: 876-880.
11. Kusiluka, L.J.M. and D.M. Kambarage, 1996. Diseases of small ruminants in sub- saharan, Africa. Center for tropical Vet. Med. Scotland, pp: 97-99.
12. Hasan, M.H., 2012. Diagnosis of some blood parasites in cattle and sheep in Mosul, Iraq. J.Vet. Sci., 26: 57-61.
13. Iqbal, A., B.B. Khan, M. Tariq and M.A. Mirza, 2008. Goat- A potential dairy animal:Present and future prospects. Pak. J. Agri. Sci, 2: 227-230.
14. Baloch, K.H., A.B. Rind and I.T. Hassani, 2006. Some common ailments and areawise distribution of small ruminants in district Bolan, Balochistan. J. App. Em. Science, 1: 220-222.
15. Afzal, M. and A.N. Naqvi, 2004. Livestock resources of Pakistan: Present status and future trends. Quarterly Sci. Vision, 9: 3-4.
16. Tageldin, M.H., A.A. Fadiya, A.A. Sabra and S.I.A. Ismaily, 2005. Theileriosisin sheep and goats in the Sultanate of Oman. Trop. Anim. Health and Prod, 37: 491-493.
17. Khan, 2013/14. Country Report-Pakistan. Asian-Australasian Dairy Goat Network. AnimalSciences Institute, pp: 66-67.
18. Khan, M.F.U., F. Ashfaq and M.A. Masood, 2014. Study on fattening potential of different sheep and goat breeds under different plan of nutrition in Pakistan. J. Anim. Plant Sci., 24: 83-86.
19. Ademola, I.O. and T.E. Onyiche, 2013. Haemoparasites and Haemotological parameters of slaughtered ruminants and pigs at Bodija Abattoir, Ibadan, Nigeria. African J. Bio. Medical Res., 16: 101-105.
20. EL-Metenawy, T.M., 1999. Blood parasites of sheep and goat at AL-Qassim Region, Saudia Arabia. J. Pak. Vet., 19: 43-45.
21. Basheir, O.B., M.H. Khitma, A.G. Atif and A.R.G. Ahmad, 2012. Traditional and modernpractices in the diagnosis, treatment and prevention of animal diseases in SouthKordofan Stat. J. Cell and Ani. Bio., 1(15): 213-225.
22. Jatau, I.D., A. Abdulganiyu, A.I. Lawal, O.O. Okubanjo and K.H. Yusuf, 2011.Gastrointestinal and Haemoparasitism of sheep and goats at slaughter in Kano, Northern-Nigeria. Sokoto J. Vet. Sci, 9: 7-11.
23. Stuen, S., 2016. Hemoparasites in small ruminants in European countries: challenges andclinical relevance small ruminants. Reshttp:/ dx.doi.org/ 10.1061/jsmallrumres,2016.03.005
24. Talat, R., T. Khanum and A. Hayat, 2005. Studies on mammalian haematozoan parasites of NWFP, Pakistan. Pak. J. Biol. Sci., 8: 726-729.
25. Altay, K., N. Dumanli and M. Aktas, 2007. Molecular identification, genetic diversity and distribution of *Theileria* sp.and *Babesia* sp. infecting small ruminants. Vet. Parasitol., 147: 161-165.
26. Al-Khalifa, M.S., H.S. Hussein, F.M. Diab and G.M. Khalil, 2009. Blood parasites oflivestock in certain regions in Saudia Arabia. Saudi J. Biological Sci., 16: 63-67.

27. Sulaiman, E.G., S.H. Arslan, Q.T. Obaidi and E. Daham, 2010. Clinical, haematologicaland biochemical studies of Babesiosis in native goats in Mosul. Iraqi J. Vet. Sci., 24: 31-35.
28. Ijaz, M., A. Rehman, M.M. Ali, M. Umair, S. Khalid, K. Mehmood and A. Hanif, 2013.Clinico-epidemiology and therapeutical trials on Babesiosis in sheep and goats inLahore, Pak. J. Anim. & Plant Sci., 23: 666-669.
29. Mousa, S.M.H., M. Fakhar, M. Sharif A. Paghe, M. Sharbatkhori, R. Tavakoli and S. Gholami, 2013. Molecular identification of *ovine Babesia* sp. In north of Iran. J. Molecular Med., 1: 35-39.
30. Theodoropoulos, G., M. Gazouli J.A. Ikonomopoulos, V. Kantzoura and A. Kominakis, 2006. Determination of prevalence and risk factors of infection with *Babesia* in small ruminants from Greece by polymerase chain reaction amplification. Vet. Parasitol., 135: 99-104.
31. Razmi, G.R., A. Naghibi, M.R. Aslani, K. Dastjerdi and H. Hossieni, 2003. Anepidemiological study on Babesia infection in small ruminants in Mashhad suburb,Khorasan province, Iran. Small Ruminant Research, 50: 39-44.
32. Niu, Q., Z. Liu, J. Yang, P. Yu, Y. Pan, B. Zhai, J. Luo and H. Yin, 2016. Geneticdiversity and moleculer characterization of *Babesia motasi* in small ruminants and ixodid ticks from china. Infection, Genetics and Evolution., pp: 8-15.
33. Naz, S., A. Maqbool, S. Ahmad, K. Ashraf, N. Ahmad, K. Saeed, M. Latif, J. Iqbal, Z. Ali, K. Shafi and I.A. Nagra, 2012. Prevalence of Theileriosis in small ruminants in Lahore, Pak. J. Vet. Anim. Sci., 2: 16-20.
34. Irshad, N., M. Qayyum, M. Hussain and M.Q. Khan, 2010. Prevalence of tick infestation and Theileriosis in sheep and goats. Pak. Vet. J., 30: 178-180.
35. Salman, K.O. and M.H. Kareem, 2012. Clinical and hematological studies of Theileriosis inlocal breed goats in middle of Iraq (Baghdad, Diala and Al-Anbar). Al-Anbar J. Vet. Sci., 5: 1-8.
36. Youquan, L., X. Zhang, Z. Liu, Z. Chen, J. Yang, H. He, G. Guan, A. Liu, Q. Ren, Q. Niu, J. Liu, J. Luo and H. Yin, 2014. An epidemiological survey of Theileria infections in small ruminants in central china. Vet. Parasitol., 200: 198-202.
37. Gebrekidan, H., A. Hailu, A. Kassahun, I. Rohouova, C. Maia, D.T. Frank, A. Warburg and G. Baneth, 2014. Theileria infection in domestic ruminants in northern Ethiopia. Vet. Parasitol., 200: 31-38.
38. Durrani, S., Z. Khan, R.M. Khattak, M. Andleeb, M. Ali, H. Hameed, A. Taqddas, M. Faryal, S. Kiran, H. Anwar, M. Riaz, M. Sajid, R.S. Sheikh, M. Ali and F. Fv, 2012. A comparison of the presence of *Theileria ovis* by PCR amplification of their SSU rRNA gene in small ruminants from two provinces of Pakistan. Asian Pacific J. Trop. Dis., pp: 43-47.
39. Fatima, M., S. Saeed, R.S. Sheikh, M. Ali and F. Iqbal, 2015. A study on moleculer detection of *Theileria lestoquardi* by PCR amplification in apparently healthy small ruminants from five districts of Southern Punjab. Pak. J. Zool., 47: 441-446.
40. Ali, A., M. Ijaz, A.Z. Durrani, M.M. Ali, K. Mehmood and A.J. Sabir, 2014. Prevalenceand chemotherapy of Anaplasmosis in clinically affected small ruminants in the RiverRavi region, Lahore. Pak. J. Zool., 46: 876-880.
41. Said, M.B., H. Belkahia, M. Karaoud, M. Bousrih, M. Yahiaoui, M.D. Jedidi and L. Messadi, 2015. First molecular survey of *Anaplasmabovis* in small ruminants fromTunisia. Vet. Micro., 179: 322-326.
42. Alsaad, K.M., Q.T. Al-obaidi and S.A. Esmaeel, 2009. Hematological and biochemicalstudy on the effect some common blood parasites in native goats in Mosul area. J. Vet.Sci., 32: 101-106.
43. Nadia, M. Osman, M. Fadl and A.H.A. Rahman, 2012. Haematological profile andparasitological diagnosis of *Trypanosoma vivax* infection in Sudanese Nubian goats.U. K. J. Vet. Med. & Anim. Prod., 3: 28-45.
44. Hamedani, M.A., Z. Khaki, S. Rahbari and M.A.A. Hamedani, 2012. Hematologicalprofiles of goats naturally infected with *Anaplasmaovis* in north and northeast Iran. Comp. Clin. Pathol., 21: 1179-1182.
45. Sakyi, L.B., E.B.M. Koney, O. Dogbey and A.R. Walker, 2004. Incidence and prevalence of tick-borne harmoparasites in domestic ruminants in Ghana. Vet. Parasitol., 124: 25 42.