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Morphological characterization of ectoparasites infesting *Capra aegagrus hircus* in Lucknow (U.P)

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Abstract

This study was conducted to identify various ectoparasites infesting common goat *Capra aegagrus hircus*. Examinations of goats for ectoparasites were carried out in Village Chandrawal and Telibagh region of Lucknow, Uttar Pradesh, during four months, from February to May 2022. One hundred fifty-seven (157) goats were examined, in which 74 (47.13%) goats were infected with one or more species of ectoparasites. Out of 157 goats, 15 (9.55%) goats were infested with *Rhipicephalus spp*, 35 (22.29%) goats were infested with *Hyalomma spp*, 7 (23.56%) goats were infested with *Linognathus spp* and 15 (9.55%) goats were infested with *Ctenocephalides spp.* Identification of these ectoparasites was done based on morphological characteristics. Ectoparasites were identified morphologically by using light microscopy and scanning electron microscopy.

Keywords: ectoparasites, scanning electron microscopy, *Capra aegagrus hircus*, *Hyalomma*, *Linognathus*, *Ctenocephalides*, *rhipicephalus*

Introduction

Goats are considered to be the most important and resourceful species of livestock throughout the world. It has a significant space in small scale farming and rural economy of developing societies leading to rising employment and increasing household income. Goats were firstly domesticated for production of milk, hair and leather production (Hassan *et al*., 2011) [31]. Goats have been linked with the humans since the beginning of agriculture and domestication of animals. Goats were domesticated by humans about 10,000 years (Solaiman *et al*., 2010) [28]. Goats are very good meat producer for human consumption because of its short intervals between generations and absence of any type of religious taboos related with their meat as goats are a rich protein source and helps in overpass the gap of protein malnourishment among consumers. Goat production is a profitable business in many parts of world because of huge demand of dietary protein (Anaeto *et al*., 2009) [27].Goats are most important domestic small ruminant in the sense of concerning total numbers and production of fibre and food product (Olanike *et al*., 2015) [40].The domestic goat (*Capra aegagrus hircus)* is mainly kept for meat, milk, hair, fibre, hides and skin (Food and Agricultural Organization). These ruminants are mainly domesticated by the poor farmers that's why goats are also known as Poor man's Cow (FAO, 2012) [35].Rearing of goat is an important part in economy of underdeveloped nations because of their low space requirements, low maintenance cost, climatic adaptations, high demand of goat product and high prolificacy. India acquires second position in World's goat population and China ranks first. In India, goats are the second most reared livestock species in India (Indian Livestock census 2012) [36].The whole goat has a high economic value. Goat's milk is easily digestible and very tasty. Goat's dung is used as agro fertilizer. Skin, hides and wool are good source of earning foreign currency. In India, about 95% of goat's meat eats up locally and per capita availability is far below the necessity. That's why there should be increase in goat production for meat consumption, export and quality leather production (Devi *et al*., 2014) [38]. Goat meat is consumed by more than 40 countries (Pinkerton, 1995) [7]. Asia is the largest producer of goats with 55% of world goat population is, in India 35.2% production, India 35.2%, China 29.3% production and Pakistan 12% (Devendra, 1983) [5]. the goat meat consumption is highest in China followed by India and Pakistan (FAO, 2009) [26].The enormous increase in protein demand due to rapid urbanization, population growth and growth in income in developing nations require sufficient knowledge of parasites associated with goats (Idris and Umar, 2007) [20].

Ectoparasitism play remarkable role in the economics of goat rearing because by declining the growth rate, productive performance and animal health (Ghosh *et al*., 2007) [23].The ectoparasitic infestation causes high economical losses to goat farmers. These ectoparasites causes some direct or some indirect impact on their hosts. The direct impact includes inflammation, skin irritation, blood loss, toxic effect and allergic reactions. The indirect impact causes self-mutilation by itching, restlessness and disturbance in normal feeding and rest of animals (Taylor *et al*., 2007) [21]. Ectoparasites transfer many types of life-threatening pathogens of animals (Soulby, 1982) [4]. When skin becomes abraded by rubbing, biting and scratching of the infested animals, other type of infection like mylasis may occur which result in death of animals (Paul *et al*., 2012) [34]. In small ruminants parasitic skin diseases are caused by ticks, lice, fleas, keds and mites.

The most common ectoparasites of goats are ticks, lice and mites (Nooruddin and Mondai, 1996) [10]. Ticks are blood sucking arthropodan parasites they attach to the host body to take blood meal. In a day ticks and its instar suck about 2.0 ml blood and female ticks suck thirty times of her body weight and more than that (Sangwan *et al*., 1995) [9].

According to an estimate more than 80% of goat population is infected with Ticks and these ticks are responsible for Tick-borne diseases such as hemorrhagic fever, anaplasmosis, viral encephalomyelitis, theileriosis and louping ill (Opara and Ezeh.,2011) [32]. Tick also transmits many types of zoonotic diseases like Rocky Mountain spotted fever, Lyme Borreliosis and Tickborne encephalitis (Gray, 1998) [14]. There are three families of Ticks which consist of total 907 species of Ticks first is Nutalliellidae with a single species *Nutalliella namaqua* second is Argasidae which include soft ticks with 186 species and third is Ixodidae which include hard Ticks with 720 species (Barker and Murrell, 2008) [25]. Lice are also an ectoparsite which affect on health and production of animals. Heavy infestation with louse causes proritus, excoriation, alopecia and self wounding (Wall and Shearer, 1997) [12].Goat lice only attack goat (host specific) and also on Sheep. Goat lice are mainly divided in two categories first is Anoplura (sucking lice) and second is Mallophaga (Tally *et al*., 2015) Fleas are ectoparasites of goats. Blood meal size of flea is small, repeated feeding and high infection causes fatal iron deficiency anaemia in very young animals (Wall and shearer, 1997) [12].

Goats were commonly infected with two species of fleas- 1. *Ctenocephalides felis* (cat flea) and 2.*Echidnophaga gallinacea* (stick tight flea). Mites are common ectoparasites of goats. Goats mainly infected with many species of mites but the most commonly found species of mites on goats are *Sarcoptes scabiei*, *Demodex caprae*, *Psoroptes cuniculi* and *Chorioptes bovis*. *Demodex caprae* cause nodule and dermal papules which result in condition called demodectic mange in goats (Tally *et al*., 2015) [41].

Materials and methodology

Study area

Ectoparasites of goats were collected from two sites Village Chandrawal and Telibagh of district Lucknow, Uttar Pradesh. To identify species of ectoparasites morphological study was done in the Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow.

Study period

The investigation was carried out for a period of 4 months study from February 2022 to May 2022.

Sample collection

Total 157 goats were examined to study different types of ectoparasites. The parasites are collected from the different body parts of goats (head, ear, neck, belly, back, udder, legs and tails). Goats were investigated thoroughly by close check-up, by palping and by parting the hairs opposed to their general direction. During collection precautions were taken so that mouth parts and appendages were preserved. Many ectoparasites including fleas, lice and ticks were collected by hand from their site of attachment. After collection ticks, lice and fleas were preserved in 70% ethyl alcohol in clean, well stopped glass vials for further identification of the parasites.

Sample preservation, processing and Examination

All the ectoparasites collected from goats (Ticks, Lice and Fleas) were transported to the laboratory of Department of Zoology, Babasaheb Bhimrao Ambedkar University in glass vials with 70% ethanol.

Sample preparation for light microscopy

The specimens were softened by boiling them in 10% KOH solution. After boiling, specimens were washed in distilled water. These were passed through different grades (30%, 50%, 70%, 90%, 95% and 100% aqueous solutions) of ethyl alcohol for 1 hour each. They were transferred into the pure xylene for 2 min for clarification. Then liquid Canada balsam as kept on specimen on the glass slide and cover slip was applied for mounting of the specimen. After mounting slides were examined under Light microscope for identification of Ectoparasites.

Sample preparation for Scanning electron microscopy

Samples were fixed in 2.5% glutaraldehyde for 3 hours at 4^0C after fixation samples were washed with 0.1M phosphate buffer, for 3 times each of 15 min at 4ºC. Specimen was dehydrated by using increasing concentration of Acetone (30%, 50%, 70%, 90%, 95%, 100%) for 30 min in each to remove water. After dehydration samples were dried by air drying and specimens were mounted on aluminium stubs with carbon tape. Now specimens were dried by critical point drying (Critical point i.e. 31.5ºC at 1100 p.s.i.). Samples were coated with platinum to make the sample conductive. Specimens were observed and images were captured using Scanning Electron Microscope for ectoparasite identification.

Identification of ectoparasites

Morphology of ectoparasites were studied in the lab with the help of dissecting (4X), compound (10X) and Scanning Electron Microscope. Ectoparasites were identified done according to the descriptions and keys given by Walker (2003) [15] and Lewis (1967) [1].

Result

In the present study, 157 goats were investigated, in which 74 (47.13%) goats were found to be infected with different ectoparasites (Tick, Fleas and Lice).

Table 1: Shows No. of Goats infested with ectoparasites

No. of Goats affected (%)	Ectoparasites
50%	Tick, Lice
64.2%	Tick, Lice, fleas
30.7%	Tick
58.8%	Tick, Lice, Fleas
45.45%	Tick
60%	Tick, Lice
40%	Tick, Lice, Fleas
23.07%	Tick, Lice
68.75%	Tick, Lice, Fleas
16.66%	Lice
46.66%	Tick, Lice, Fleas

72 (47.13%) out of 157 goats were found to be infected with 2 species of ticks which were *Rhipicephalus spp* and *Hyalomma spp*, belonging to the Ixodidae family of ixodida order. Single species of lice (sucking lice) which was *Linognathus spp*, belonging to the Linognathidae family, Anopleura sub order, Phthiraptera order and single species of fleas which was *Ctenocephalides spp*, belonging to the Pulicidae family of Siphonaptera order was found.

Table 2: Shows Species based infestation in 157 goats.

Ectoparasites	Percentage of goat infested
Rhipicephalus spp	9.55%
Hyalomma spp	22.29%
Linognathus spp	23.56%
Ctenocephalides spp	3.18%

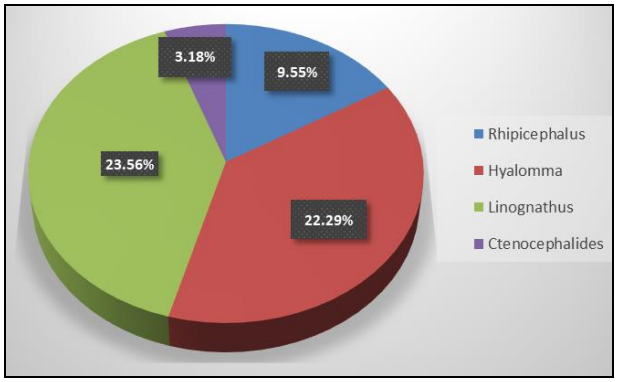

Fig 1: Pie chart showing prevalence of ectoparasites

1. *Rhipicephalus*: Out of 157 goats, 15 (9.55%) goats were infested with *Rhipicephalus spp. Rhipicephalus* were identified on the basis of following morphological characteristics like it's mouth parts were anterior, palp articles were very small, basis capitula had well defined angular lateral margins which make hexagonal shape of whole basis Capitula. Their legs had no any pale rings and legs were slender and pulvilli were present. Eyes were present and flat to slightly convex. Festoons were present in males (but unclear in female when females were fed). Large spiracular plates were present and found posterior to the legs. All over the spiracle plates Spiracle goblets were scattered. Ventral plates were present only in males. Anal groove was posterior to the anus. Coxae 4 were of normal size and Coxae 1 had large and equal paired spurs.

2. *Hyalomma:* Out of 157 goats, 35 (22.29%) goats were infested with *Hyalomma spp. Hyalomma* were identified on the basis of morphological characteristics like it's mouth parts were anterior and palp article was longer than articles 1 and 3. Basis capitula had medium angular lateral margins. Legs were slender and legs had pale rings. Pulvilli were present. Scutum was present in only females. Eyes were present and always very convex. Festoons were present in males and in females (but unclear when females were fed). Large spiracular plates were present and found posterior to legs. All over the spiracle plates spiracle goblets were scattered. Ventral plates were present only in males. Anal groove was present posterior to the anus. Coxae 4 were normal size and Coxae 1 had large and equal paired spurs.

3. *Linognathus:* Out of 157 goats, 37 (23.56%) goats were infested with *Linognathus spp. Linognathus* were identified on the basis of morphological features like oval shaped, brown,

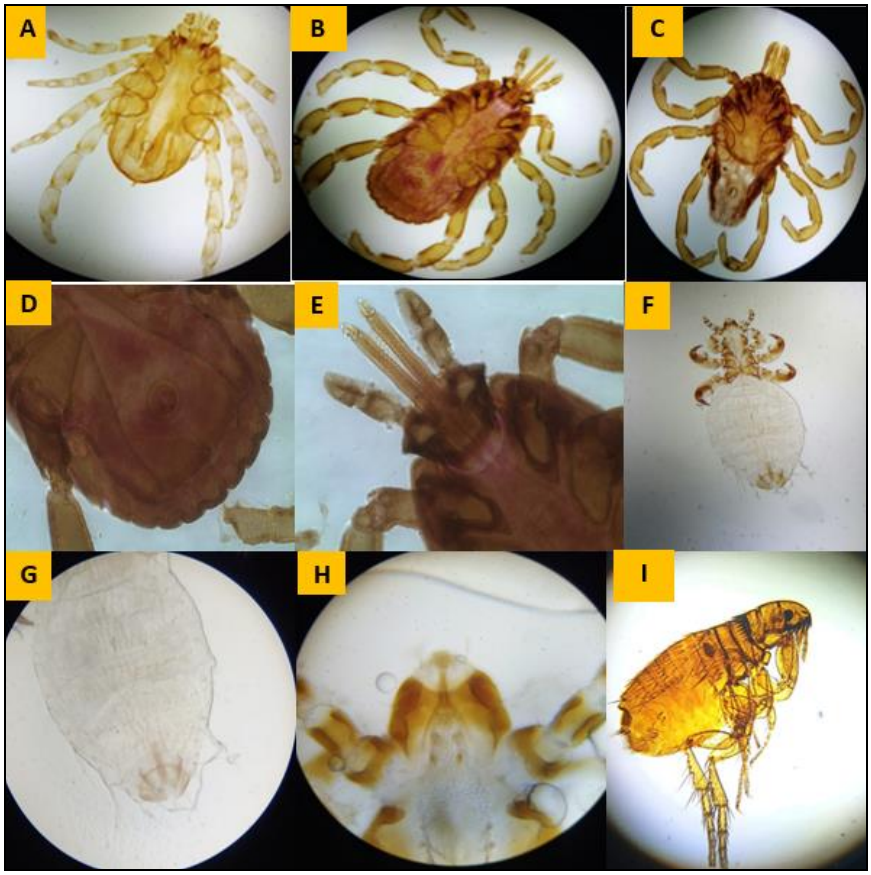

Fig 2: Light micrographs of ectoparasites *(*A)*Rhipicephalus* whole mount showing ventral side, (B) *Hyalomma* female whole mount, (C)*Hyalomma* male whole mount, (D) *Hyalomma* abdomen in enlarge, (E) *Hyalomma* mouth part in enlarge, (F) *Linognathus* whole mountshowing ventral side, (G) *Linognathus* Abdomen in enlarged, (H) *Linognathus* mouth part in enlarged, (I) *Ctenocephalides* whole mouth showing lateral side.

Dorsoventrally flattened and covered with hairs. Antennae was filiform type, five segmented and long, first segment was rectangular, wider and bigger than others, second segment was small and rectangular in shape, third and fourth segment was square shaped smaller than second segment,

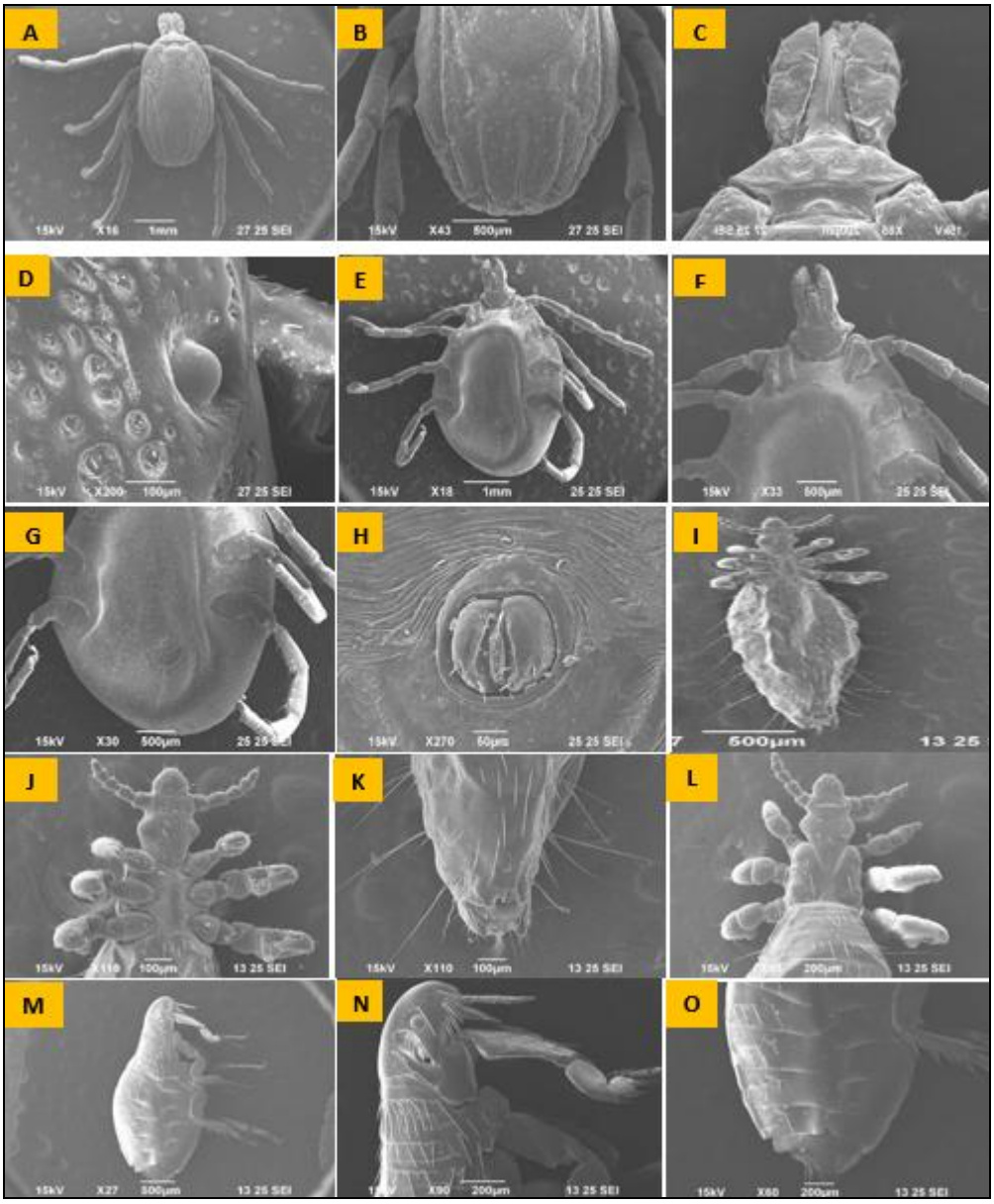

Fig 3: Scanning electron micrographs of Ectoparasites (A) *Hyalomma* male whole mount showing dorsal side, (B) *Hyalomma* posterior part in enlarge, (C) *Hyalomma* anterior part in enlarge, (D) *Hyalomma* eye, (E) *Hyalomma* female whole mount showing ventral side, (F) *Hyalomma* female mouth part in enlarge, (G) *Hyalomma* female posterior part in enlarge, (H) *Hyalomma* anus in enlarge, (I) *Linognathus* female whole mount ventral view, (J) *Linognathus* anterior part in enlarge. (K) *Linognathus* posterior part in enlarge. (L) *Linognathus* showing dorsal view, (M) *Ctenocephalides* showing lateral view, (N) *Ctenocephalides*, mouth parts, (O) *Ctenocephalides*, abdomen.

Fifth segment was triangular and smaller than other segment. Mouth parts was piercing and sucking type largely retracted internally into a ventrally located cephalic sac when not used. The labrum was only visible externally, it forms part of short eversible, snout like tube knows as haustellum. Thorax is as long as the head, quite narrow and parallel sided, sternal plate of thorax was slender and small the single pair of mesothoracic spiracles were located dorsally. Legs were clinging type and fore legs were smaller than the mid and hind leg. Large, elongate oval shaped abdomen with six pairs of spherical spiracles that open on abdominal segments 3-8. Gonopophyses of the females were slender, convergent and just rounded at the apex, yellow coloured and carry a group of slender setae, median plate present which was large and elongate and apical lobes being apparent somewhat short. Phallobase of male was more or less cylindrical in shape, yellow in colour, parameres was cylindrical in shape suddenly narrow at the 1/3 of apical part which was curved strongly without a mesalexpantion.

4. *Ctenocephalides:* Out of 157 goats, 15(9.55%) goats were infested with *Ctenocephalides spp. Ctenocephalides* were identified on the basis of morphological characteristics

like small, wingless, holometabolous insect with a tough cuticle bearing many bristles and combs of broad flattened spine. Body was laterally flattened which was hairy. Ctenocephalides fleas had genal combs and pronotal combs. In each segment of body there was group of combs and ctenidia. Genal combs or genal ctenidium were present in the ventral head and pronotal combs or pronotal ctenidiums were present in the posterior area of prothorax. A number of seta-bearing notches were present in the hind tibia along dorsal margins. Genal ctenidium formed of eight or nine spines oriented horizontally. Presence of two to three spines in the metepisternite with elongated and pointed head.

Discussion

The study was conducted in Chandrawal village and Telibagh in Lucknow region to identify morphology of ectoparasites of goats. A total of 157 goats were examined from which 74 (47.13%) goats were found to be infected with three types of ectoparasites which were ticks, lice and fleas. Only one species of lice was identified is *Linognathus spp*. This spp was also observed by (Prelezov *et al*., (2020) [52] and Ajith *et al*., (2017) [47] in goats. The goats which were less than 6 months (kids) were highly infected with *Linognathus.* Same findings were also observed by Kushiluka and Kambarage (1996) [11] and Horak *et al*. (2001) [16]. Kids are highly infected with ectoparasites due to their less develop immune system (Barmon *et al*., 2010) [30].

Goats are often hosts of fleas as well. The flea, *Ctenocephalides* was present in Goats. This flea spp. was also observed by Kusiluka *et al*., (1995) [8] and also found by Yacob *et al*., (2008) [24].

Two species of ticks were present which were *Hyalomma spp* and *Rhipicephalus spp*. These ticks were also identified by Haneef *et al*., (2019) [51] in goats and Nandi *et al*., (2017) [48]. The most frequent ectoparasites encountered were Lice. Ticks were present in very less predominance. Fleas were rarely present. Similar findings were reported by Shabir *et al*., (2018) [50].

Higher ectoparasitic burdens were encountered among goats in village Chandrawal than in Telibagh this is due to difference in rearing system in both the areas in village Chandrawal, goats are reared under semi- intensive system and in Telibagh, goats reared under intensive system. These findings were reported by Rony*et al*, (2010) [29] and also reported by Rabbi (2006) [19] they observed that goats reared under semi-intensive system had heavy ectoparasitic infestation than extensive and intensive system of rearing.

The ectoparasitic prevalence was significantly higher in females than males. Similar observation was reported by Shabir *et al*., (2018) [50], Kabir *et al*. (2011) [33] and Chakrabarti (1994) [6] and Riaz *et al*. (2017) [49]. Female goats were highly infected during lactation and gestation period because during this period goats were less active and had low immunity and so they were subjected to heavy loads of ectoparasites. Similar observation was reported by Zita *et al*., (2014) [39].

The goats less than six month's age (kids) were highly infected with ectoparasites than adults and growers, this may due to their weak immune system. This was also observed by Shabir *et al*., (2018) [50] and also found by Jugessur *et al*., (1998) [13] and Manan *et al* (2007) [22] and Sultana *et al*. (2015) [42]. However, these findings did not match with Shah *et al*. (2015) [43] who observed higher tick prevalence was in adult (60%) goats than in young animals (40%).

Majority of goats had light to medium tick infection which indicating that they are not favourable hosts for heavy establishment if the parasite. This may be in line with the observation made by Iwuala and Okpala (1978) [3] that cattles and horses were potentially good maintenance hosts for ectoparasites than other types of livestock.

It was found during the study that there were mixed infections of both immature and mature ticks of which the immature ticks were greater in number than the mature ones. Similar findings were also reported by Odogu and Okaka, (2016) [45]. This observation is mach with report of Baker and Ducasse (1968)[2] and same findings were also found by Bryson *et al*., (2002) [17], (Maclvor and Horak, 2003)[18]also observed that goats are the host of large numbers of immature ticks and less number of adult ticks.

Black coated goats are highly susceptible to the infection in comparison to other goats. Similar finding were also reported by Jannatul *et al*., (2016) [46] that the black coat colour showed higher prevalence.

It was also found during the study that goats were infested with ectoparasite when warmth and adequate moisture combine, and animals are overcrowded in unhygienic condition. This was also reported by Idris *et al*., (2007) [20].

Ctenocephalides felis was the only species of fleas found to be infecting goats. Similar findings were observed by Soulby, (1982) [4]. *Ctenocephalides felis* was firstly the ectoparasite of cats and dogs were found to be the only flea species which infect goats (Soulby, 1982) [4].

In goats heavy tick, flea and louse infection causes poor body condition which suggests that ectoparasites are responsible for loss of production. This may also believable that the poor body condition of goats which is caused by other factors like malnutrition made the goats more susceptible for parasitic infestation and hence the heavy infection observed. Sam finding were also reported by Cornall and Wall (2015) [44] and Kusiluka *et al*., (1995) [7].

Conclusion

Result revealed that in the study area 47.13% of goats were infected with ticks, lice and fleas. Infestation with lice by *Linognathus* species was only found. The flea, *Ctenocephalides* was also found in goats. Infestation with tick was mostly of a mixed type and includes *Hyalomma* and *Rhipicephalus spp.* Ectoparasitic diseases are worldwide problem and considered as a major barrier in the health and productivity performance of animal. Therefore, it can be concluded that ticks, lice and fleas are the most common ectoparasites in Lucknow region, which are directly or indirectly involved in different diseases and also hamper in production. It was found that prevalent to ectoparasite infestation is far more in Semi intensive system than other management system. Heavy infestation with lice associated with poor body condition and anaemia leading to reduced productivity in animals. Control of these ectoparasites can probably minimise the losses. Insecticides and acaricides should be sprayed timely inside the animal shed for prevention of parasitic infestation in animals. In addition to insecticides and acaricides, animal owners should use insect growth inhibitors. Regular deworming of animals and proper husbandry practices also suggested to the animal owners.

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