



PREVALENCE OF LICE INFESTATION IN DOMESTIC PIGEON COLUMBA LIVIA DOMESTICA IN SOUTH-EASTERN PAKISTAN

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Author's contribution

A.G.A is the principal author, A.K.M collects the samples, N.A perform the experiment, Z.A.L analysis the samples, and M.C.M compiles the data.

Key words:

Domestic, Pet pigeon, Lice, Prevalence, Pakistan

ABSTRACT

The present study was carried out to determine prevalence of lice infestation in pet pigeons in Umerkot region of south-eastern Pakistan. The samples were collected from a total of 100 pet pigeons from fourteen different localities of Umerkot city. The data recorded includes point prevalence, diversity and intensity of lice infestation in different breeds of pigeons kept under different management systems. In the study area pigeons were found to be infested with two lice species i.e. *Columbicola columbae* and *Menopon gallinae*. The overall prevalence of the lice infestation was recorded as 80% (80/100). The highest infestation rate was recorded in the area of Oad Mohalla and Kolhi Daro 100% (5/5) followed by Sanbhwani, Babar, Khosa Mohalla with the infection rate as 80% (5/4) and Chandiram Mohalla 80% (10/8), in Pathan Mohalla the infestation rate as 70% (10/7), in Machi and Lohar Mohalla the infestation rate was 60% (5/3) and in Sheikh Mohalla infestation rate was also 60% (10/6), respectively. Interestingly, female pigeons were found more susceptible with highest infestation rate 86% (42 / 49) as compared to 74% in males. It was also found that adult birds are more susceptible to the infestation than that of young birds while birds with poor body condition was highly susceptible to the infestation indicating clear correlation with nutrition and lice infestation. Meanwhile, severity of infestation in affected birds was recorded as 60%, 28.75%, and 11.25% as low, medium and high infestation, respectively. It was found that lice infestation is an important problem in pigeons in the study area and might be the source of infection, which needs proper attention to control infectious diseases.

1. INTRODUCTION

The arthropods constitute over 80% of all known species in the animal kingdom and widely distributed to almost every known habitat [1]. Among the arthropods, ectoparasites which live or interact with the surface of the body belongs to the class Insecta and Arachnida, which both constitutes almost 80% of the arthropod species [2]. Arthropod ectoparasites may have a variety of direct and indirect effects on their hosts as a result of their activity affecting their productivity and is considered as a major

concern of animal health and welfare [3, 1]. Parasitic diseases are ubiquitous and the infection results in morbidity and mortality of their hosts. Among the parasitic diseases, ectoparasite infestation has a variety of direct and indirect effects on the health of host. Direct effects of ectoparasites are skin diseases including myiasis, pruritis, and dermatitis with toxic or allergic response. While indirect effects include their role in disease transmission and self-wounding consequence due to allergic response or irritation [4, 5, 6]. Commonly reported ectoparasites including ticks, lice, fleas and mange mites cause a wide range of health problems [7, 8]. Lice are considered as permanent ectoparasites that spend their whole life on a host and cause cutaneous and

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systemic effect on hosts, including dermatitis and anemia in case of high infestation [9]. In addition, lice infestation contributes to the economic losses due to damage to feathers or skin/ hide in the form of light flecks and spots followed by secondary bacterial infection or scratching behavior and inflammation of the skin [10, 11, 12]. Domestic pigeons (*Columba livia domestica*) are the most successful pet birds adapted to human habitation worldwide [13, 14]. As a pet bird, pigeons are considered to be attractive and raised from long period of time as a religious or cultural symbol [15, 16]. Being a pet bird, the interaction of pigeons with man and other wild and domestic birds makes them a potential carrier of zoonotic parasites and serves as a source of infection to human and other birds/animals such as being a reservoir of many infectious pathogens which largely affects specially poultry industry by means of transmitting disease to flocks [17, 18, 13, 19, 20]. Despite this socio-economic significance, the ectoparasitic diversity focusing on the prevalence and magnitude of ectoparasite infestation in birds have not been widely assessed in Sindh province of south-eastern Pakistan. Therefore, information on prevalence, their magnitude, distribution in different environments, and potential risk factors of ectoparasites of birds is significant because the outcome could be used to make objective decisions on control strategies. The finding would also help in developing new strategies to meet the current shortfall of production created by the rapidly increasing human population. Hence, the present study was aimed (1) to identify lice infestation in pigeons in Umerkot region, (2) to determine the prevalence of lice infestation in relation to risk factors such as environment, body condition, age and sex, and (3) to recommend suitable preventive and control strategies.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted on pigeons (*Columba livia domestica*) raised as pets in and around of Umerkot city, south-eastern part of Pakistan, from March, 2014 to August, 2014 during the wet and dry seasons. Umerkot city is located along the Pak-Indian border between latitude 2522'0.120"N and longitude 6943'59.880"E with altitude of 3 m above sea level. Umerkot district has medium size sandy mountains with annual rainfall is about 350 mm. The average temperature in the hottest months is around 45 °C. Parasite sampling A total of 100 pet pigeons (51 male and 49 female) were examined during the study period in 3 visits. A total of 57 pigeons were examined during first visit, whereas the number of pigeon was 28 and 15 in second and third visits, respectively. In all visits the pet pigeons were randomly examined for parasite collection. Sampling procedure Parasite sample were collected as described by [21]. Briefly, pigeons were kept in an air tight box with a lid

that permitted the protrusion of bird's head to allow respiration. A cotton swab dipped in chloroform was placed at the bottom of the box. The pigeon was restrained with its body in the box for 20 minutes to stimulate dying parasites fell off. The bird was taken out of the box, and the parasites were collected.

2.2 Preservation of parasites (Lice)

During this study pigeons were only infested with lice which were preserved in 70% alcohol containing a drop of glycerin as described by the [22]. Permanent mounts were prepared on microscopic glass slides by using Canada balsam as mounting agent. Cover slips were applied over the parasites to make them permanently mounted, and then slides were kept in incubator at 37 °C and allowed to dry. Identification of ecto-parasite (Lice). The identification of lice was carried out using morphological characters as described by and [22, 23].

3. RESULTS

In the present study a total of 14 localities with 5-10 pigeons from each flock comprising a total of 100 pet pigeons were randomly inspected to determine the prevalence and intensity of lice infestation in pigeons. The lice infestation in pigeons was observed in three consecutive visits during March to August 2014 in which overall lice prevalence was observed as 80% (Table 1).

Table 1. Prevalence percentage of lice in pet pigeons during 3 different visits around Umerkot.

Visit No.	Pigeons examined	Pigeons Infested	Prevalence
1	57	47	82.45%
2	28	24	85.71%
3	15	9	60.00%
Total	100	80	80.00%

In the present study two main species of lice were identified as *Columbicola columbae* and *Menopon gallinae*. Further, the results showed that there is a wide variation in the prevalence of lice infestation in different regions of study area. The prevalence percentage data indicates that all the fourteen sites sampled for determination of lice infestation found positive for the presence of infestation of either lice species in pet pigeons with variation in prevalence percentage among different sites. The observations showed that highest infestation rate (100%) in Oad Mohalla and Kolhi Daro, followed by 90% infestation rate in near Umerkot gate, Udhepuri Mohalla and Sheikh Mohalla, 80% infestation rate in Babar, Sanbhwani, Khosa, Khatri and Chandiram Mohalla, 70% infestation rate in Pathan Mohalla, 60% in Machi and Sheikh Mohalla sabzi mandi and Lohar Mohalla, respectively (Table 2).

Prevalence of lice infestation in *Columba livia domestica*

Table 2. Point prevalence of lice infestation in pet pigeons in different areas of Umerkot.

S. No	Sampling site	Pigeons examined	Pigeons infested	Prevalence
1	Oad Mohalla	5	5	100%
2	Kolhi Daro	5	5	100%
3	Near Umerkot gate	10	9	90%
4	Udhepuri Mohalla	10	9	90%
5	Sheikh Mohalla	10	9	90%
6	Babar Mohalla	5	4	80%
7	Sanbhawani Mohalla	5	4	80%
8	Khosa Mohalla	5	4	80%
9	Khatri Mohalla	10	8	80%
10	Chandiram Mohalla	5	4	80%
11	Pathan Mohalla	10	7	70%
12	Sheikh Mohalla sabzi mandi	10	6	60%
13	Machi Mohalla	5	3	60%
14	Lohar Mohalla	5	3	60%
Total		100	80	80%

Table 3. Sex-wise prevalence of lice infestation in pet pigeons in Umerkot region.

S. No	Sex	Pigeons examined	Pigeons infested	Prevalence
1	Male	51	38	74%
2	Female	49	42	86%
Total		100	80	80%

Meanwhile, the comparison of lice infestation in pigeons of different body conditions showed that the infestation rate in pigeons were higher in poor body condition (bony) compared to fair and fatty body conditioned. Among the total 100 pet pigeons examined, which comprised of 25 pigeons with bony body status which were infested at the rate of 100%, where as with fair body status, 62 pigeons were examined of which were infested at the rate of 79%. Moreover, in fatty body status 13 pet pigeons were examined and out of these 06 birds were infested which showed 46% infestation rate (Table 4). These results demonstrated that infestation rate is directly related to the health status of birds and poor body conditioned birds are more prone to parasitic infestation when compared with the healthy birds which might be due to immune status of the body.

Table 4. Body status wise prevalence of lice infestation in pet pigeons.

S. No	Body Status	Pigeons examined	Pigeons infested	Prevalence
1	Bony	25	25	100%
2	Fair	62	49	79%
3	Fatty	13	6	46%

Total	100	80	80%
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Interestingly, it was found that young birds (1-6 months) was less likely to be infested with lice comprising 70% infestation rate than that of adults (7 months onward) in which infestation rate was recorded as 95%. These results imply that adult birds are more prone to the lice infestation when compared to the young birds which might be due to more interaction of adult birds with other infested birds or the source of infestation (Table 5).

Table 5. Age-wise prevalence of lice infestation in pet pigeons.

Age	Pigeons examined	Pigeons infested	Prevalence
1 -6 Month	60	42	70%
7 Months onward	40	38	95%
Total	100	80	-

Further, it was found that lice most likely to infest on the areas covered by plenty of feathers with soft skin provided with enough blood supply specially under the wings. While affected skin was found red, slightly swelled with pin point hemorrhages. However, severe infestation results in rough skin with histopathological lesions comprises loss of dermal layers. In order to analyze the parasitic burden or severity of infestation, the infestation was scored in both male and female from 1 to 120 parasites with 1 was low severity and 120 was considered as high severity (Table 6). Further depending upon the parasitic burden, severity of infestation was categorized into three categories, low, medium and high. In the present study it was found that mostly birds were infested at low severity comprising 60% of the total infested birds, whereas medium infestation level was observed in 28.75% and highest infestation levels was observed in 11.25% of the total birds infested. Moreover, sampled pigeons were categorized into 14 different breeds based on their phenotypic characteristics. Out of total 100 infested birds, it was observed that birds of Motiyo breed were severely affected as compared to other breeds followed by Haro and Pamposh breeds. While pigeon breed sampled were included Pamposh Kalsoro, Kalikuch Kuldmo, Cheno, Kalsoro, Kashni, Pamposh motiyo, Ambals, Dobaz, Bajro, Kasori, Chadbar breeds. Parasitic infestation also largely affected by environmental factors specially hosing condition which further predispose birds to the infestation or facilitate the development of infection. In this study it was observed that pet pigeons were mainly raised under three different conditions including the cemented, kacha and netted housing. Further the effect of hosing condition on infestation rate indicates that in kacha house a total of 88% birds infested with lice which was higher as compared to 80% and 74%

in cemented and netted houses, respectively. As learnt from the farmers, remedies for different ectoparasitic

Table 6. Severity of lice infestation in pet pigeons.

S. No	Lice Burden	Total pigeons infested	♂	♀	Prevalence	
					♂	♀
1	1-10	6	1	5	16.66%	83.34%
2	11-20	13	5	8	38.46%	61.54%
3	21-30	19	10	9	52.63%	47.37%
4	31-40	10	6	4	60.00%	40.00%
5	41-50	6	3	3	50.00%	50.00%
6	51-60	7	4	3	57.14%	42.86%
7	61-70	4	1	3	25.00%	75.00%
8	71-80	6	4	2	66.66%	33.34%
9	81-90	2	-	2	-----	100.00%
10	91-100	3	1	2	33.33%	66.67%
11	101-110	1	-	1	-----	100.00%
12	111-120	2	2	-	100.00%	-----
13	121-130	1	1	-	100.00%	-----
Total		80	38	42	47.50%	52.50%

diseases of animals as well as birds were used in study area but the choice of remedies used mainly depends on the awareness of the farmers. As revealed during the study, there is no valid treatment protocol followed by the farmer to treat lice infestation. However, lice infestation in pigeons was mostly treated by mechanically removing lice from the body and in some cases provided with anti-lice shampoo and tiger powder which both contains pyrethrin derivatives as an anti-lice agent to prevent lice infestation.

4. DISCUSSION

This is the first study to compare the prevalence, diversity and intensity of lice infestation in pet pigeons raised in temperate area of south-eastern Pakistan. It was found that pet pigeons in the study area are severely infested with lice with almost 80% infestation rate which is considered very high in terms of parasitic prevalence. Although lice infestation is generally asymptomatic owing to low pathogenicity of parasite but still can affect pigeon's health through direct feeding on host results in skin/feather damages, hemorrhages or irritation as a direct effect and serving as a vector for several protozoan parasites that again results in pathogenicity even some time mortality. The present work showed that pigeons infested with either species of lice or mixed infestation. The higher infestation of mixed species of *Columbicola columbae* and *Menopon gallinae* was found in different breeds of pigeons. This pattern of infestation maybe associated with the fact that both of these species can cohabit without harming each other and successful infestation. The interaction of two or more species on the same host indicates low inter-specific competitive interaction characterized by simultaneous infestations that may not be detrimental to the two species. However,

presence of only these species may describe that these birds serves as a natural or transient host. These findings are in agreement with previous reports which describe presence of two more lice infestation in the same host which represents mixed infestations. These results are in accordance with the previous findings in different parts of the world. Lice species identified in the present study were previously reported in pigeons and other pet birds reared in different agro-ecological zones [24, 25, 26, 27, 28]. Further, the parasitic diversity maybe associated with several factors which include age sex, management system and interaction with source of infestations. The results indicate higher prevalence of parasites in the sampling area maybe due to the fact that pet pigeons could have higher interactions or frequent exposure to the source of infestation or the conditions that favored the frequent contact and the management system which further predispose birds to the infestation. The non-significant association between sex and parasite infestation during the present study, indicates that both males and females are equally exposed to the acquisition of parasites and their sex-related physiognomy may not confer any differences in infestation. This result is in agreement with the observations of [18, 19], who did not find significant difference between male and female pigeons in overall lice infestation. The lower infestation rate in young birds as compared to adults maybe associated with higher interaction of adult birds with other birds especially wild birds which serve as a source of infestation. However, adult birds that are already infested with different parasites may serve as a source of infestation for their young [22]. Previous studies indicate that there are no any statistical differences in lice infestation among different age groups kept under different conditions [29]. However, higher infestation rate in young birds is reported when compared to adults which may be due influence of several factors such as source of infection, environmental conditions and management systems [30]. Overall, a relatively high prevalence of lice infestation was detected in pigeons from the sampling sites. Similar data from previous studies [17, 13, 15] suggesting that lice infestation or parasitic burden maybe associated with interaction with other birds or source of infection. It was found that the pigeons were severely infested with lice representing 80% infestation rate in sampling areas during different visits. [31] reported that lice infestation is higher in winter than in the rainy and summer seasons. Similarly, higher infestation rate was found in the present study in first round of visits (March, April) than last session of visits (August) in the pet pigeon. The data is further supported by the evidence as reported by [32] that when temperature is cooler than optimum, eggs do not develop while hotter temperature prevent egg lying and kill the lice. Moreover, it was found that lice infestation in pigeons can result in skin damages, irritation and allergy with abnormal behavior such as head

shaking, stamping, skin switching and scratching, although with less severity but at least can affect bird's health [22]. Concluded that lice mostly prevail a successful infestation in wings and other covered body parts with soft skin and plenty of blood supply. Furthermore, pigeons housed in kacha system were more infested (80%), than cemented (80%) and netted (74%). These results are in line with the findings of [33] who reported the highest parasitic infestation in semi-intensive system (59.7%) followed by extensive system (33.5%) and intensive system (8.27%). While, pigeons under poor nutritional level are more vulnerable to ecto-parasitic infestation than pigeons with normal health. This might be the reason that bony conditioned pigeons were highly infested (100%), in comparison with fair (79%) and fatty (46%). The present study agrees with the earlier study of [34], who found that malnourished animals are more susceptible to any infection as they are immune compromised. In response to the awareness about the treatment and precautionary measures to prevent lice infestation in birds, majority of the owners used to off lice by hand picking, where only few owners used anti-lice drugs to get rid of lice infestation when birds are severely infestation. The contrast in between the present and earlier findings can be explained by the fact of variation of geographical location of experimental area, topography, the composition of soil type and humidity, lack of control group of population and most importantly, the changed climatic condition of the earth.

5. CONCLUSION

At the present we have only sampled lice from pigeons from different sites in urban areas, so further studies are required on lice infestation in pet birds from other localities especially rural areas to determine parasitic diversity. The present study revealed that pet pigeons raised for different purposes specially as a pet birds are severely (80%) affected by lice infestation and were found to be infested with atleast two different species of lice. Further, the non-significant differences in the lice prevalence among male and female birds were found. However, it was demonstrated that adults were more infested as compared with young birds. Meanwhile, differences in the prevalence in different housing systems were also recorded. Such difference in the prevalence and parasitic diversity maybe due to the result of differences in agro-climate, management system, environmental factors, breed of the birds and treatment measures taken to prevent infestation in the respective study area.

6. CONFLICT OF INTEREST

All authors have declared that there is no conflict of interest regarding publication of this article.

REFERENCES

- [1] R. Wall and D. Shearer, "Veterinary Ectoparasites: Biology, Pathology and Control," 2nd Edition, Blackwell Science, 2001.
- [2] A.G. Marshall, "The ecology of ectoparasitic insects," Academic Press, London, 1981.
- [3] P.W. Ewald, "Host-parasite relations, vectors and the evolution of disease severity," *Annu. Rev. Ecol. Syst.*, vol. 14: pp. 465–85, 1983.
- [4] M.A. Taylor, R.L. Coop, R.L. Wall, "Veterinary Parasitology," London: Blackwell, 2007.
- [5] E.U. Edosomwan, E. Amadasun, "Ectoparasite of some bird species in Ogba Zoo in Benin City. S. West Niger Biosci. Res. Comm.," vol. 20: pp. 231–235, 2008.
- [6] T. Abeyayehu, F. Endris, M. Berhanu, Z. Endrias, Study on the prevalence of ectoparasite infestation of ruminants in and around Kombolcha and damage to fresh goat pelts and wet blue (pickled) skin at Kombolch Tannery, Northeastern Ethiopia," *Ethiop. Vet. J.*, vol. 15(2): pp. 87-101, 2011.
- [7] G. Mullen, L. Durden, "Medical and Veterinary Entomology," Academic Press, San Diego, CA, 92101, 2002.
- [8] D.G. Pugh, "Sheep and Goat Medicine," United States of America, Saunders, Elsevier Sci. pp. 19-25, 2002.
- [9] G.M. Urquhart, J. Armour, J.L. Duncan, A.M. Dunn, F.M. Jennings, "Veterinary Parasitology," 2nd Edition, Blackwell Science, London, pp. 141-205, 1996.
- [10] O. Nafstad, H. Gronstol, "Variation in the level of grain defect light flecks and spots on cattle hides," *Acta. Vet. Scand.*, vol. 42: pp. 91-98, 2001.
- [11] G. Lopez, J. Figuerola, R. Soriguer, "Carotenoid-based masks in the European Goldfinch *Carduelis carduelis* reflect different information in males and females," *Ardea* vol. 96: pp. 233–242, 2008.
- [12] M.S. Liebana, M.A. Santillan, A.C. Cicchino, J.H. Sarasola, P. Martinez, S. Cabezas, M.S. Bo, "Ectoparasites in free-ranging American Kestrels in Argentina: implications for the transmission of viral diseases," *J. Raptor Res.*, vol. 45: pp. 335–341, 2011.

- [13] S.M. Marques, R.M. Quadros, C.J. Da-Silva, M. Baldo, "Parasites of pigeons (*Columba livia*) in urban areas of langes, Southern Brazil. *Parasitol. Latinoam*" vol. 62: pp. 183-187, 2007.
- [14] Z.Q. Zhang, "Animal Biodiversity: An Outline of Higher-level Classification and Survey of Taxonomic Richness," *Zootaxa*, vol. 3703, pp. 1–82, 2013.
- [15] J.E. Cooper, "A veterinary approach to pigeons," *J. Small Anim. Pract.* Vol. 25: pp. 505-516, 1984.
- [16] R.W. Harlin, "Pigeons. The veterinary clinics of North America," *Small Anim. Pract.* Vol. 24: pp. 157-173, 1994.
- [17] J.S. Kaminjolom, E.S. Tikasingh, G.A.A.A. Ferdinand, "Parasites of the common pigeon (*Columba livia*) from the environs of Port of Spain, Trinidad," *Bull. Anim. Health Prod. Afr.*, vol. 36: pp. 194-195, 1988.
- [18] B. Senlik, E. Gulegen, V. Akyol, "Ectoparasites of domestic pigeons (*C. l. domestica*) in bursa province," *Turk. Parazit. Derg.*, vol. 29: pp. 100-102, 2005.
- [19] K.L. Adang, S.J. Oniye, A.U. Ezealor, P.A. Abdu O.J. Ajanusi, "Ecto-parasites of domestic Pigeon (*Columba livia domestica*, Linnaeus) in Zaria, Nigeria," *Res. J. Parasitol*, vol. 3: pp. 79-84, 2008.
- [20] N. Bunbury, C.G. Jones, A.G. Greenwood, D.J. Bell, "Epidemiology and conservation implications of *Trichomonas gallinae* infection in the endangered Mauritian pink pigeon," *Bio. Conser.* Vol. 141: pp. 153–161, 2008.
- [21] A. Begham, S. Sabrina, "Prevalence and seasonal variation of ecto-parasites in pigeon, *Columbae livia* (Gmelin, 1789) of Dhaka, Bangladesh," *Bangladesh. J. Zool*, vol. 39: pp. 223 – 230, 2011.
- [22] E.J.L. Soulsby, "Helminths, Arthropods and Protozoa of Domesticated Animals. 7th Ed., Bailliere Tindall, London, UK.," ISBN-13: 9780702008207,; 809, 1982.
- [23] J.P. Fabiyi, "Arthropod parasites of domestic fowl and guinea fowl on the J. O. S Plateau, Northern Nigeria," *Trop. Anim. Health Prod.* Vol. 12: pp. 193-194, 1980.
- [24] J.A. Conti, D.J. Forrester, "Interrelationships of parasites of white-winged doves and mourning doves in Florida," *J. Wildl. Dis.*, vol. 17: pp. 529-536, 1981.
- [25] M. Rosciszewska, A. Petryszak, Z. Bonczar, M. Duda, "Mallophaga of pigeons in Cracow," *Wiad. Parazit*, vol. 42: pp. 235-242, 1996.
- [26] F.Z. Mushi, M.G. Binta, R.G. Chabo, R. Ndebele, R. Panzirah, "Parasites of domestic pigeons (*C. l. domestica*) in sebele garborone," *Botswana. J. S. Afr. Vet. Assoc.*, vol. 71: pp. 249-250, 2000.
- [27] A. Petryszak, M. Rosciszewska, Z. Bonczar, N. Pospiech, "Analyses of the population structures of mallophaga infesting urban pigeons," *Wiad. Parazit*, vol. 46: pp. 75-85, 2000.
- [28] A. Dovc, O. Zorman-Rojs, R.A. Verges, H.V. Bole, U. Krapez, M. Dobeic, "Health status of free living pigeons (*Columba livia domestica*) in the city of Ljubljana, Slovenia," *Acta Vet. Hung.*, vol. 52: pp. 219-226, 2004.
- [29] A.C. Santos, J.L.H. Faccini, "A cross -sectional study of louse infestation caused by *Damalina caprae* (trichodectde mallapho) in semi-arid regional of the state of Paraiba" *Rev. Bras. Parasitol. Vet. (Brazil)* vol. 5: pp. 43- 46, 1996.
- [30] O.M. Radostitis, C.C. Gay, D.C. Blood, K.W. Hinchcliff, "Veterinary Medicine. A text book of the diseases of cattle, sheep, pig and horse," 9th edition, 2000.
- [31] K. Sanjay, K.D. Prasad, A.R. Deb, "Seasonal prevalence of different ectoparasites infecting cattle and buffaloes," *J. Res.*, vol. 16: pp. 159-163, 2007.
- [32] O.M. Radostitis, C.C. Gay, K.W. Hinchcliff, P.D. Constable, "A textbook of the diseases of cattle, sheep, goats, pigs and horses," 10th ed. Saunders, Edinburgh, London, pp. 1585-1612, 2007.
- [33] G. Lapage, "Monig's Veterinary Helminthology and Entomology," 5th edi. Bailliere, Tindall and Cox Ltd. London, UK. Pp. 556-723, 1962.
- [34] A.K.M.A. Rabbi, "Parasitism in Black Bengal Goats in relation to different feeding systems," M.S. thesis. Department of Parasitology, Bangladesh Agricultural University, Mymensingh, 2006.