

## A Survey of Parasites of Domestic Pigeons (*Columba livia domestica*) in South Khorasan, Iran

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**Abstract:** The aim of this study was to determine the prevalence, intensity and species of internal and external parasites in pigeons in Birjand, South Khorasan from October 2008 to September 2009. The samples were taken from 102 pigeons (44 nestlings and 58 adults). Total 5 species of nematodes and cestodes were collected from alimentary canals. *Ascaridia colombae* (16.66%), *Hadjelia truncata* (1.96%), *Cotugnia digonopora* (13.79%), *Raillietina magninumida* (18.62%), *Raillietina achinobothridia* (32.35%). Faecal samples were collected and examined through the centrifugal flotation method using Sheather's saturated sugar solution for diagnosis of *Eimeria* sp. *Eimeria* sp. identified in 40.19% of pigeons. Cryptosporidium oocysts were identified in 2.94%. About 2 blood smears taken from each bird were stained with Geimsa. Giemsa methods detected 47/05% of Haemoproteus cloumbae. The infestation rate with *Trichomonans gallinae* was 57.84%. Total 4 species of ectoparasites were collected from feathers and subcutaneous nodules as follows: feathers: *Pseudolynchia canariensis* (63.72%), *Columbicola columbae* (79.41%), *Menopen galline* (44.11%). subcutaneous nodules: *Laminosioptes cysticola* (1.96%). From the parasitic fauna seen in this study, it is imperative to institute an integrated parasitic control through constant changing of litter, regular use of antihelminthics, anticoccidials and dusting of birds with pesticides.

**Key words:** Domestic pigeons, parasites, subcutaneous, pesticides, South Khorasan, Iran

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### INTRODUCTION

Pigeons are seen in more region of the world except for the poles. Pigeons live side by side with humans and other animal species in the nature and they are bred as a source of food as a hobby, symbol and for experimental aims (Cooper, 1984; Harlin, 1994). It's interaction with man and other domestic and wild birds, portends it as a potential carrier of zoonotic parasites (Adang *et al.*, 2008). They have a role in spreading some zoonoses to people as well as being a reservoir of many parasitic diseases for poultry (Kaminjolo *et al.*, 1988; Piasecki, 2006). Various parasites significantly impede pigeon growth, development and productivity, it at times result to death, especially, the sqabs.

Such sick birds are often slaughtered pre-maturely by the breeders instead of seeking for their cure. However, little is known about the socio-economic importance, management and health aspects of these birds. Due to perceived little importance of pigeons, little attention in

terms of research has been directed towards the species in Iran. Information on the parasitic infection of domesticated pigeons in different region of Iran appears to be poorly documented (Derakhshanfar *et al.*, 2004; Youssefi *et al.*, 2010; Moghaddas *et al.*, 2010; Pirali-Kheirabadi *et al.*, 2008).

The current study was therefore, designed to provide holistic information on parasites of domestic pigeons with the hope of designing an integrated parasite control for these birds. The aim of this study was to determine, the prevalence, intensity and species of internal and external parasites in domestic pigeon in Birjand area in South Khorasan of Iran and to obtain information about the effects of some factors such as maturity on parasitic infections.

### MATERIALS AND METHODS

**Study area:** Study was carried out in Birjand, capital South of Khorasan province in the east of Iran during

October 2008 to September 2009. The samples were taken from 102 pigeons (44 nestlings and 58 adults). From Birjand. This city (South Khorasan) is geographically located at latitude (32.88 degrees) 32° 52' 48" North of the Equator and longitude (59.22 degrees) 59° 13' 11" East of the Prime Meridian on the map of the world.

#### Investigation of the parasites

**Antemortem examination:** The blood samples were collected using an insulin syringe inserted through a brachial vein catheter. Each sample provided blood smears, fixed with methanol and stained with Giemsa dyes. The slides were analyzed under light microscopy using an oil immersion objective. For diagnosis of trichomonans gallinae, wet and sterile swab were taken from surface of mouth, throat and larynx of pigeons and after preparation slide smears, the samples were studied under the light microscope. All parasites were identified using the parasitological keys (Soulsby, 1982).

**Postmortem examination:** The ectoparasites were collected as described by Soulsby (1982), briefly after killing the pigeons by anesthesia, they were immediately placed in a polythene bag and the parasites collected after leaving the pigeons. The ectoparasites were preserved for identification purposes in 70% alcohol. Subcutaneous nodules of each bird were fixed in 10% potassium, heated for 20 min in a jar containing water and their sediments were searched for parasite. Routine examinations were made of the entire alimentary tract, respiratory system, liver, heart, kidney and reproductive tract as follows. The nematodes and cestodes removed and washed by water and a number of nematodes were cleared in lactophenol for identification and the rest of them stored in 70% alcohol containing 5% glycerin for parasitological examination. Cestodes were fixed in 10% formalin and stained with carmine acid for further studies.

The worms were identified under light microscope according to helminthological keys Soulsby (1982). After three washes of the faecal samples, the sediment from each sample was mixed with Sheather's saturated sugar solution, centrifuged and then examined under a microscope for the presence of protozoan oocysts (*Eimeria* oocysts). Detection of cryptosporidium oocysts was performed using the formalin-ether sedimentation method and the modified Ziehl-Neelsen staining technique and then examined under a microscope for the presence of protozoan oocysts.

**Statistical analysis:** The computer software, SPSS Version 9.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for analysis. To compare relative frequency of

infection between adult and nestling of pigeons  $\chi^2$ -tests was used. Differences were considered significant when  $p < 0.05$ .

## RESULTS AND DISCUSSION

**Parasite species:** The prevalence of parasite species identified in nestlings and adults pigeons is shown in Table 1-3. Out of a total of 102 pigeons (44 nestlings and 58 adults pigeons) examined, 43 (42.15%) were infected with one or more species of helminthes also 17 (16.66%) of the pigeons were infected by nematodes and 26 pigeons (25.49%) were infected with the cestodes. Pigeons were infected with one or more helminth. About 91.17% (93/102) pigeons were infected with one or more ectoparasites. Giemsa methods detected 47.05% (48/102) of *Haemoproteus columbae*. *Eimeria* sp. was identified in 40.19% (41/102). *Cryptosporidium* oocysts were identified in 2.94% (3/102) of the samples.

A total of 5 different worms species were identified in alimentary tract, 4 different ectoparasites and 4 protozoan species. In total 3 species of cestodes belonging to family, Davaineidae and 1 species of nematode belonging to family Heterakidae was found in both nestlings and adults and 1 species of nematode belonging to family Hedruridae was found in adults pigeons. No trematodes were found in the study. The 4 different species of ectoparasites identified were *Pseudolynchia canariensis* (pigeon fly), *Columbicola columbae*, *Menopen galline* found in both nestlings and adults while *Laminosioptes cysticola* was found in adult only. This bird, however did not show any lesions either in breast or in neck muscles. The protozoan species identified was found in both nestlings and adult pigeons (Table 3).

The analysis showed that worms were significantly ( $p < 0.05$ ) more prevalent in adults than in the nestlings. *T. gallinae* and *Eimeria* sp. were significantly ( $p < 0.05$ ) higher in nestlings pigeons than in adults while the *H. columbae* and *P. canariensis* were significantly ( $p < 0.05$ ) higher in adult pigeons than in nestlings. Also infection rate of *Cryptosporidium* sp. was not significantly ( $p > 0.05$ ) in adult pigeons than in nestlings.

In Iran, a limited number of studies have been performed in relation to parasite infections in pigeons (Derakhshanfar *et al.*, 2004; Pirali-Kheirabadi *et al.*, 2008). This is the first study to compare, the prevalence and intensity of parasite among pigeon species in the birjand area, South Khorasan of Iran. Categorization of sampled birds into adult pigeons and nestlings enabled the study to show that helminthes, *H. columbae* and *P. canariensis* were significantly more prevalent in adult than in

Table 1: Prevalence of helminth in nestlings and adults pigeons

Helminth	Adults		Nestlings		Overall prevalence %	Statistical significance p<0.05
	n	%	n	%		
<i>Ascaridia colomb</i>	14	24.13	3	6.88	16.66	S
<i>Hadjelia truncata</i>	2	3.44	0	0.00	1.096	NS
<i>Raillietina magninumida</i>	15	25.86	4	9.09	18.62	S
<i>Raillietina achinobothridia</i>	27	46.55	6	13.63	32.35	S
<i>Cotugnia digonopora</i>	12	20.68	2	4.54	13.72	S
Total helminth	34	58.62	9	20.45	42.15	S

NS: Not Significant (p&gt;0.05); S: Statistically significant (p&lt;0.05)

Table 2: Prevalence of ectoparasites in nestlings and adults pigeons

Ectoparasites	Adults		Nestlings		Overall prevalence %	Statistical significance p<0.05
	n	%	n	%		
<i>Pseudolynchia canariensis</i>	44	75.86	21	47.27	63.72	S
<i>Columbicola columba</i>	43	74.13	38	86.36	79.41	NS
<i>Menopen galline</i>	26	44.82	19	43.18	44.11	NS
<i>Laminosioptes cysticola</i>	2	3.44	0	0.00	1.96	NS
Total ectoparasites	52	89.65	41	93.18	91.17	NS

NS: Not Significant (p&gt;0.05); S: Statistically significant (p&lt;0.05)

Table 3: Prevalence of protozoan in nestlings and adults pigeons

Ectoparasites	Adults		Nestlings		Overall prevalence %	Statistical significance p<0.05
	n	%	n	%		
<i>Haemoproteus cloumbae</i>	36	62.06	12	27.27	47.05	S
<i>Trichomonas gallinae</i>	18	31.03	41	93.18	57.84	S
<i>Cryptosporidium</i>	2	3.44	1	2.27	2.94	NS
<i>Eimeria</i> sp.	17	29.31	24	54.54	40.19	S

NS: Not Significant (p&gt;0.05); S: Statistically significant (p&lt;0.05)

nestlings while *T. gallinae* and *Eimeria* sp. were significantly (p<0.05) higher in nestlings pigeons than in adults. The present findings are more or less similar pattern was previously observed line with observations by Msoffe *et al.* (2010). According to the various studies performed in different regions of the world, *Ascaridia columbae*, *Capillaria*, *Dispharynx*, *Hadjelia truncata*, *Syngamus* and *Tetrameres* sp. were commonly identified in pigeons (Gicik and Arslan, 2001; Razmi *et al.*, 2007; Sari *et al.*, 2008). The 2 species of nematode encountered (*Ascaridia columbae* and *Hadjelia truncata*) were of low percentage prevalence.

This is probably due to the mode of infection as the infective egg dries off when the environment is harsh. Perhaps, most of the infective stages that got to the final host were through earth worms as transport host.

Despite their low prevalence, severe haemorrhagic enteritis, intestinal obstruction, reduction in egg production and subsequently death have been known to occur (Audu *et al.*, 2004). *Hadjelia truncata* has been found in the gizzard of a number of bird species in Europe and Asia. The intermediate host are various beetles (Anderson, 2000). So far, there have been only 4 reports of the pigeons infestation with this parasite from Egypt (Tadros and Iskander, 1975), Iraq (Al-Attar and Abdul- Aziz, 1985), Cyprus (Appleby *et al.*, 1995) and Iran (Razmi *et al.*, 2007). *Raillietina magninumida* was

shown to be an important cestode of pigeons. Although, this is generally considered to be a relatively harmless parasite, it will be interesting to study the reason of pigeons to be more susceptible to *Raillietina magninumida* compared to other birds. Further investigations of health status, blood parameters and growth rate of pigeons will indicate the relative effect of these worms in pigeons. The presence of three species of *Raillietina* clearly support their cosmopolitan nature in chickens, guinea fowls, turkeys, pigeons, doves and bush fowls (Soulsby, 1982; Oniye *et al.*, 2001; Audu *et al.*, 2004; Derakhshanfar *et al.*, 2004; Moghaddas *et al.*, 2010). Ants of the genera *Pheidole* and *Tetramorium* including various beetles, termites, flies and other arthropods in addition to fruits and seeds form the major diets of dove and pigeon (Adang, 1999). The arthropod portion of the food by carrying the infective stages, serves as intermediate host (Mushi *et al.*, 2000).

It may be therefore, right to postulate that the degree of prevalence is determined by levels of the infective stages present in the intermediate host and subsequently, their availability to the definitive host. The high prevalence of double infestation of the pigeons by *Columbicola columbae* and *Pseudolynchia canariensis*, compared with single infestation may be related to the fact that ectoparasites can cohabit without causing any harmful effects on each other. The interaction of 2 or more

ectoparasites on the same host may be said to be a low inter-specific competitive interaction characterized by simultaneous infestations that may not be detrimental to the 2 species. Diversity of bird ectoparasite assemblages may be related to many factors which may include home range, behaviour, size and roosting habit of the host. The results of this study confirmed the findings of other studies performed in some parts of the world (Senlik *et al.*, 2005; Mushi *et al.*, 2000; Petryszak *et al.*, 2000). Total 2 bird (1.96%) showed the presence of the cyst mite (*Laminosioptes cysticola*) which were reported in pigeons and chicken (Toro *et al.*, 1999; Eslami *et al.*, 2009).

Total 2 *Haemoproteus* species, *H. columbae* and *H. sacharovi*, occur in pigeons. The vector of *H. columbae* is *Pseudolynchia canariensis*. Both *H. columbae* and *P. canariensis* are widely distributed in the world, especially in warm and temperate climates (Soulsby, 1982). About 63.72% of pigeons examined were parasitized with *P. canariensis*. The range of pigeon flies (*P. canariensis*) recovered from a single pigeons was 1-5 flies.

Since, birds were caged together before delivery to the laboratory, it is possible that flies could have been transferred from bird to bird. Data on percentage of birds infected would not account for the variable and therefore, the ratio of flies recovered to number of birds examined was utilized to indicate fly population density. The results of this study are in line with previous finding (Gicik and Arslan, 2001; Sol *et al.*, 2000) that older individuals have higher infections of haematozoan parasites (*H. columbae*) than younger ones.

There was a noticeable relationship between the prevalence of *Haemoproteus columbae* and its vector *Pseudolynchia canariensis*. The closeness in their percentage prevalence suggests that most of the vector harbored by the pigeons were probably carrying pathogens. A higher prevalence in adults might be the result of a longer time of exposure to the parasites. However, parasites prevalence in nestlings was also high in most of the studied populations which suggest that infections generally occurred at an early age.

The lower parasite intensity in adults on the other hand is to be expected if older birds acquire a certain degree of immunity against parasites (Merila *et al.*, 1995). Alternatively, adults with high intensity of parasites could be under-represented in the populations due to their higher risk of mortality; this last hypothesis seems however, less probable in the case because existing evidence indicate that *H. columbae* rarely produces mortality in pigeons (Atkinson and van Riper, 1991). *Trichomonas gallinae* causes avian trichomoniasis and affects upper digestive and respiratory tracts

(Levine, 1985). Avian trichomoniasis caused is a disease of young birds which may result in a high mortality in young pigeons within 10 days. A high incidence of latent infection (up to 90%) has also been reported (Soulsby, 1982) where they can cause granulomatous lesions that occlude the oesophagic lumen, leading to the death of birds as a result of severe starvation. (Narcisi *et al.*, 1991). *Trichomonas gallinae* was significantly higher in nestlings pigeons (93.18%) than in adults.

The reason for the high prevalence may be due to the fact that the transmission of the parasite occurs generally when the adults feed their young but can occur through food in feeders and water (Kocan and Knisley, 1970). Adult birds may remain infected for a year or more and are a constant source of infection for their young (Soulsby, 1982). The result from this study showing *Eimeria* to occur in 40.19% is considered to be high (Lawal *et al.*, 2001).

In 29.31% of the adult pigeons and in 54.54% of the Nestling pigeons *Eimeria* oocysts were detected ( $p < 0.05$ ). Coccidiosis is one of the important protozoan diseases of birds. The disease has a subclinical course in adults but young pigeons exhibit such symptoms of clinical coccidiosis as fluffy feathers, anorexia and watery diarrhoea with mucus (Levine, 1985).

The reason for the high prevalence may be due to the fact that the pigeons in this part of the country are mainly kept on free range and also the housing they retire to are raised mud huts. This offers optimal conditions of temperature and humidity for the sporulation of the oocysts. Although, species identification of the *Eimeria* was not done in this study, earlier reports in other places have indicated the presence of *Eimeria labbeana* in majority of the samples (Taylor *et al.*, 2007).

Total 4 species of *Cryptosporidium* were isolated from the birds: *Cryptosporidium baileyi*, *C. meleagridis*, *C. parvum* and *C. galli* (Sreter and Varga, 2000; Xiao *et al.*, 2004). In addition, *Cryptosporidium* species that are known as water borne zoonotic protozoans seen in humans and many of the domestic animals are also encountered in pigeons (Rodriguez *et al.*, 1997; Sari *et al.*, 2008). *Cryptosporidium* infections commonly seen in the birds (2.94%) were reported to be found especially in young pigeons rarely at low rates (Rodriguez *et al.*, 1997; Ryan *et al.*, 2003; Sreter and Varga, 2000).

## CONCLUSION

The present study showed that, helminthes and *H. columbae* were significantly more prevalent in adults than in the nestlings. The difference of ectoparasites (*Columbicola columba* and *M. gallinae*) were not

significant in adults and nestlings, *P. canariensis* and *H. columbae* were significantly more prevalent in adult compared with the nestlings. Mixed worm infections are less frequently seen than single worm infestations in pigeons.

This results indicates that pigeons could be less susceptible to mixed infections in comparison with chickens. Whether these have more significant effect on the health and growth rate of these birds remains to be investigated. From the parasitic fauna seen in this study, it is imperative to institute an integrated parasitic control through constant changing of litter, regular use of anthelmintics, anticoccidials and dusting of birds with pesticides. It is also, important to educate the breeders of these birds on the need to adhere strictly to these control measures. These, perhaps will boost the production of domesticated pigeon, consequently augmenting the animal protein required.

## REFERENCES

- Adang, K.L., S.J. Oniye, A.U. Ezealor, P.A. Abdu and O.J. Ajanusi, 2008. Ectoparasites of domestic pigeon (*Columba livia domestica*, Linnaeus) in Zaria, Nigeria. Res. J. Parasitol., 3: 79-84.
- Adang, L.K., 1999. Some aspects of the biology of four columbid species in Zaria, Nigeria. M.Sc. Thesis, Ahmadu Bello University, Zaria, Nigeria.
- Al-Attar, M.A. and T.A. Abdul-Aziz, 1985. *Hadjelia truncata* in pigeons. Vet. Rec., 117: 535-535.
- Anderson, R.C., 2000. Nematode Parasites of Vertebrates their Development and Transmission. 2nd Edn., CABI Publishing, Oxfordshire, UK., pp: 432-433.
- Appleby, E.C., L.M. Gibbons and K. Georjoui, 1995. Distortion of the gizzard in Cyprus pigeons (*Columba livia*) associated with *Hadjelia truncata* infestation. Vet. Rec., 136: 561-564.
- Atkinson, C.T. and C. van Riper, 1991. Pathogenicity and Epizootiology of Avian Haematozoa: Plasmodium, Leucocytozoon and Haemoproteus. In: Bird-Parasite Interactions: Ecology, Evolution and Behaviour. Loye, J.E. and M. Zuk (Eds.). Oxford University Press, Oxford, pp: 19-48.
- Audu, P.A., S.J. Oniye and P.U. Okechukwu, 2004. Helminth parasites of domesticated pigeons (*Columba livia domestica*) in Zaria, Nigeria. J. Pest Dis. Vector Manage., 5: 356-360.
- Cooper, J.E., 1984. A veterinary approach to pigeons. J. Small Anim. Pract., 25: 505-516.
- Derakhshanfar, A., M.H. Radfar and N. Taefinasrabadi, 2004. A study on parasites of the digestive system and related lesions of pigeons in City of Kerman, Iran: Pathological findings. Proceedings of the 29th World Congress of the World Small Animal Veterinary Association, Oct. 6-9, Rhodes, Greece.
- Eslami, A., P. Ghaemi and S. Rahbari, 2009. Parasitic infections of free-range chickens from Golestan Province, Iran. Iranian J. Parasitol., 4: 10-14.
- Gicik, Y. and M.O. Arslan, 2001. Blood parasites of wild pigeons in Ankara Districts. Turk. J. Vet Anim. Sci., 25: 169-172.
- Harlin, R.W., 1994. Pigeons. The veterinary clinics of North America. Small Anim. Pract., 24: 157-173.
- Kaminjolo, J.S., E.S. Tikasingh and G.A.A. Ferdinand, 1988. Parasites of the common pigeon (*Columba livia*) from the environs of Port of Spain, Trinidad. Bull. Anim. Health Prod. Afr., 36: 194-195.
- Kocan, R.M. and J.O. Knisley, 1970. Challenge infection as a means of determining the rate of disease resistant *Trichomonas gallinae* free birds in a population. J. Wildl. Dis., 6: 13-15.
- Lawal, A.I., O.O. Igbozurike, O.O. Okubanjo and A.J. Natala, 2001. A comparative study of parasitism in the free range, deep litter and battery cage chickens in Zaria. J. Trop. Biosci., 1: 89-92.
- Levine, N.D., 1985. Veterinary Protozoology. Iowa State University Press, Ames, pp: 200-201.
- Merila, J., M. Bjorklund and G.F. Bennett, 1995. Geographic and individual variation in haematozoan infections in the greenfinch, *Carduelis chloris*. Can. J. Zool., 73: 1798-1804.
- Moghaddas, E., H. Borji and G.R. Razmi, 2010. Prevalence gastrointestinal parasites in pigeons of Khorasan. The Second International Veterinary Poultry Congress, 2010-02-20. <http://profdoc.um.ac.ir/paper-abstract-1015160.html>.
- Msoffe, P.L.M., A.P. Muhairwa, G.H. Chiwanga and A.A. Kassuku, 2010. A study of ecto-and endoparasites of domestic pigeons in Morogoro Municipality, Tanzania. Afr. J. Agric. Res., 5: 264-267.
- Mushi, F.Z., M.G. Binta, R.G. Chabo, R. Ndebele and R. Panzirah, 2000. Parasites of domestic pigeons (*C. l. domestica*) in sebele garborone, Botswana. J. S. Afr. Vet. Assoc., 71: 249-250.
- Narcisi, E.M., M. Sevolan and B.M. Honigberg, 1991. Pathologic changes in pigeons infected with a virulent *Trichomonas gallinae* strain (Eigberg). Avian Dis., 35: 55-61.
- Oniye, S.J., P.A. Audu, D.A. Adebote, B.B. Kwaghe, O.J. Ajanusi and M.B. Nfor, 2001. Survey of helminth parasites of laughing dove (*Streptopelia senegalensis*) in Zaria. Afr. J. Nat. Sci., 4: 65-66.
- Petryszak, A., M. Rosciszewska, Z. Bonczar and N. Pospiech, 2000. Analyses of the population structures of mallophaga infesting urban pigeons. Wiad. Parazit, 46: 75-85.

- Piasecki, T., 2006. Evaluation of urban pigeon (*Columbia livia furbana*) health status in relation to their threat to humans health. Medycyna Weterynaryjna, 62: 531-535.
- Pirali-Kheirabadi, K., M. Shakhse-Niaie and N. Hosseini, 2008. Epidemiological aspects of pigeon trichomonosis in center of Iran. Res. J. Parasitol., 3: 20-24.
- Razmi, G.R., G.A. Kalidari and M. Maleki, 2007. First report of the *Hadjelia truncata* infestation in pigeons of Iran. Iranian J. Vet. Res. Univ. Shiraz, 8: 175-177.
- Rodriguez, F., J. Oros, J.L. Rodriguez, J. Gonzalez, P. Castro and A. Fernandez, 1997. Intestinal cryptosporidiosis in pigeons (*Columba livia*). Avian Dis., 41: 748-750.
- Ryan, U.M., L. Xiao, C. Read, I.M. Sulaiman and P. Monis *et al.*, 2003. A redescription of *Cryptosporidium galli* Pavlasek, (Apicomplexa: Cryptosporidiidae) from birds. J. Parasitol., 89: 809-813.
- Sari, B., B. Karatepe, M. Karatepe and M. Kara, 2008. Parasites of domestic (*Columba Livia Domestica*) and wild (*Columba Livia Livia*) pigeons in Nigde, Turkey. Bull. Vet. Inst. Pulawy, 52: 551-554.
- Senlik, B., E. Gulegen and V. Akyol, 2005. Ectoparasites of domestic pigeons (*C. l. domestica*) in bursa province. Turk. Parazit. Derg., 29: 100-102.
- Sol, D., R. Jovani and J. Torres, 2000. Geographical variations in blood parasites in feral pigeons: The role of vector. Ecography, 23: 307-314.
- Soulsby, E.J.L., 1982. Helminths, Arthropods and Protozoa of Domesticated Animals. 7th Edn., Bailliere Tindall, London.
- Sreter, T. and I. Varga, 2000. Cryptosporidiosis in birds: A review. Vet. Parasitol., 87: 261-279.
- Tadros, G. and A.R. Iskander, 1975. *Hadjelia truncata*, a new parasite of pigeons in Egypt and its pathogenicity. J. Egyptian Vet. Med. Assoc., 35: 283-301.
- Taylor, M.A., R.L. Coop and R.L. Wall, 2007. Veterinary Parasitology. 3rd Edn., Blackwell Sciences limited, UK, pp: 874.
- Toro, H., C. Saucedo, C. Borie, R.E. Gough and H. Alcaino, 1999. Health status of free-living pigeons in the city of Santiago. Avian Pathol., 28: 619-623.
- Xiao, L., R. Fayer, U. Ryan and S.J. Upton, 2004. Cryptosporidium taxonomy: Recent advances and implications for public health. Clin. Microbiol. Rev., 17: 72-97.
- Youssefi, M.R., A.G. Sadeghian and B. Esfandiari, 2010. Prevalence of *Haemoproteus columbae* infection in *Columba livia* in North of Iran. World J. Zool., 5: 275-277.