

Prevalence of Digestive Endoparasites (Helminth and Protozoa) in Pigeon Domestic (*Columba livia*) Male and Female in Tuban

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Abstract

This research was conducted to determine the prevalence of major gastrointestinal helminthiasis and protozoal infections, the kinds of helminth and protozoa that infects and the effect of sex on pigeons in Tuban. Pigeons are taken from five The Tuban area is Widang District, Montong District, Jenu District, Soko District, Jatirogo District. Each area is taken as many as 20 pigeons consists of 10 male pigeons and 10 female pigeons. So the total sample is 100 pigeons. Laboratory examinations (microscopic) were carried out in November to December 2021. Stool samples were examined by the native method, sedimentation, and flotation. Identification using a microscope using a 40x objective scale and 10x ocular scale to determine the protozoa and worm eggs found. Data analysis using *chi square* test statistical analysis. The results showed that 81% of the samples were positive for helminthiasis infection. *Chi square* test statistical analysis showed p value 0.022 ($p < 0.05$) which means significantly different. Results show 71% of samples were positive for gastrointestinal protozoa infection in pigeons in Tuban. *Chi square* test Results Statistical analysis shows p the value of 0.123 ($p > 0.05$) which means that it is not significantly different. Type of protozoa found that *Heterakis gallinarum* (45%), *Ascaridia columbae* (42%), *Capillaria* sp. (41%), and *Eimeria* sp. (71%). That prevalence of helminthiasis in male pigeons higher (45%) compared to female pigeons (36%). Protozoa prevalence in male pigeons higher (39%) compared to female pigeons (32%).

Keywords: Tuban, Prevalence, Protozoa, Helminth, Pigeons, gastrointestinal

Introduction

Pigeons or *Columba livia*, known as pigeons, are one of the bird species in the Columbidae family and are one of Indonesia's rich fauna with high diversity (Hamid *et al.*, 2015). The potential for developing livestock commodities, which is still quite large, is the main reason for making the livestock sector a source of economic growth (Fathurohman *et al.*, 2014). The purpose of pigeon rearing is generally divided into consumption pigeons, fancy pigeons, and carrier pigeons.

Pigeons can be carriers of lice, mites, and gastrointestinal parasites (Sivajothi and Reddy, 2015). Pigeons have potentially become hosts or surrogate hosts for several cases of helminthiasis in domestic poultry, due to their close phylogenetic relationship (Adang *et al.*, 2008). Pigeons can be a source of various zoonotic

helminthic diseases for humans and other birds, hosts for various intestinal parasites including Acanthocephala, Cestoda, Nematodes, and Trematodes (Sivajothi and Sudhakara, 2015). Parasites can cause various problems, symptoms, and very large losses, including stunted growth, decreased egg productivity in pigeons. Avian ectoparasites and endoparasites are common in the tropics, where livestock standards are poor and climatic conditions also favor parasites (Imura *et al.*, 2012; Badparva *et al.*, 2015).

Parasitic diseases that can infect pigeons are helminthiasis and protozoa. Nematodes such as *Ascaridia* sp., *Heterakis gallinarum*, and *Capillaria* sp. have been categorized as a common parasite of domestic chickens and pigeons in Iraq (Abdulla and Mohammed, 2013; Al-Jaumeili and Aljoburi, 2015; Al-Zubaidei, 2015). Protozoa found in the digestive tract of



pigeons consist of the families Eimeriidae, Trichomonadidae, Monocercomonadidae, Diplomonadidae (Taylor *et al.*, 2007).

Based on a large number of pigeon enthusiasts in Tuban Regency, and research on endoparasites in Tuban has never been reported, it is necessary to conduct research on the prevalence of helminthiasis and protozoa in pigeons in five sub-districts in Tuban Regency, called Widang, Jatirogo, Montong, Soko, and Jenu, as well as looking at the differences in prevalence in male and female pigeons. If the data on the prevalence of helminthiasis and protozoa in pigeons are known in Tuban Regency, it will be useful in efforts to prevent the spread of helminthiasis and protozoan pigeons.

Materials dan Methods

The research was conducted from October to December 2021, at the Department of Veterinary Parasitology of Veterinary Medicine Universitas Airlangga. The samples taken in this study were 100 pigeons taken from 5 sub-districts in Tuban Regency, 20 samples each district and divided into 10 samples of female pigeons and 10 samples of male pigeons.

The materials used in this study were 10% formalin, 2% potassium dichromate, water, distilled water, and saturated sugar. The tools used are hand glove, sample pot, plastic cup, stirrer, filter, centrifuge tube, centrifuge, tube rack, pipette, cover glass, object-glass, and microscope.

Examination of Pigeon Feces Using the Native Method

Take a small number of feces using the tip of a small stirring glass or stick and then spread it over the object-glass and add 1-2 drops of water, then flatten and cover with a cover glass. Then it was examined using a microscope with a magnification of 100x (Paramitha *et al.*, 2017).

Examination of Pigeon Feces Using the Sedimentation Method

Examination using the sedimentation method is done by taking 2 grams of feces, then put into a test tube. Added physiological NaCl up to 3/4 of the tube, then closed using a cotton swab. The test tube was centrifuged at 1500 rpm for 10 minutes. The supernatant was discarded and left a little, took the precipitate using a pipette, the precipitate was dripped on the object-glass and covered with a cover glass. Read using a microscope with a magnification of 100 to 400 times (Regina *et al.*, 2018).

Pigeon Stool Examination Using the Floating Method

The method of examining the floating method is to make a suspension of feces and water using a ratio of 1: 10 to form a filtrate. The filtrate was put in a centrifuge tube and centrifuged at 1500 rpm for 5 minutes. After the supernatant looked clear, the supernatant was discarded and refilled with water, the tube was centrifuged at 1500 rpm for 5 minutes. This was repeated three times until the supernatant was clear. Once sufficient, the entire supernatant was discarded until a precipitate remained. The precipitate was added with saturated sugar solution to a height of 2 cm from the mouth of the tube and centrifuged at 1500 rpm for 5 minutes. The saturated sugar solution is dripped until it looks convex at the mouth of the tube. Cover the tube with a cover glass, and wait for 5 minutes. Lift the cover glass and place it on the object-glass, then observe it through a microscope with a magnification of 100x to 400x (Sucitrayani *et al.*, 2012).

Results and Discussion

Research conducted in November - December 2021 using 100 pigeons in five areas of Tuban Regency using a native, sedimentation, and floating method of stool examination showed that worm eggs were detected in 81 samples of pigeons, with a prevalence of 81%. Protozoa were also detected in 71 samples of pigeons, with a prevalence of 71% (Table 4.1 and Table 4.2). Worm eggs found in pigeons in 5 regions of Tuban Regency were *Heterakis gallinarum*, *Ascaridia columbae*, and *Capillaria* sp. species. The protozoa found in these pigeons were *Eimeria* sp.

Table 1. Results of Examination of Worm Eggs on Male Pigeons in Tuban Regency

| Region | <i>Heterakis gallinarum</i> | <i>Ascaridia columbae</i> | <i>Capillaria</i> sp. | Mixture |
|----------|-----------------------------|---------------------------|-----------------------|-----------------|
| Widang | 6/20 (30%) | 6/20 (30%) | 7/20 (35%) | 8/20 (40%) |
| Jatirogo | 6/20 (30%) | 6/20 (30%) | 5/20 (25%) | 6/20 (30%) |
| Montong | 6/20 (30%) | 5/20 (25%) | 5/20 (25%) | 6/20 (30%) |
| Soko | 5/20 (25%) | 5/20 (25%) | 7/20 (35%) | 7/20 (35%) |
| Jenu | 6/20 (30%) | 3/20 (15%) | 4/20 (20%) | 4/20 (20%) |
| TOTAL | 29/100 (29%) | 25/100 (25%) | 28/100 (28%) | 31/100 (31%) |

Table 2. Results of Examination of Worm Eggs on Female Pigeons in Tuban Regency

| Region | <i>Heterakis gallinarum</i> | <i>Ascaridia columbae</i> | <i>Capillaria</i> sp. | Mixture |
|----------|-----------------------------|---------------------------|-----------------------|-----------------|
| Widang | 3/20 (15%) | 2/20 (10%) | 2/20 (10%) | 2/20 (10%) |
| Jatirogo | 3/20 (15%) | 2/20 (10%) | 7/20 (35%) | 3/20 (15%) |
| Montong | 3/20 (15%) | 4/20 (20%) | 3/20 (15%) | 2/20 (10%) |
| Soko | 5/20 (25%) | 4/20 (20%) | 4/20 (20%) | 4/20 (20%) |
| Jenu | 2/20 (10%) | 2/20 (10%) | 2/20 (10%) | 1/20 (5%) |
| TOTAL | 16/100 (16%) | 14/100 (14%) | 18/100 (18%) | 12/100 (12%) |

Table 3. Protozoa Examination Results on Male Pigeons in Tuban District

| Region | <i>Eimeria</i> sp. | Mixture |
|----------|--------------------|-----------------|
| Widang | 8/20 (40%) | 8/20 (40%) |
| Jatirogo | 8/20 (40%) | 8/20 (40%) |
| Montong | 7/20 (35%) | 5/20 (25%) |
| Soko | 8/20 (40%) | 7/20 (35%) |
| Jenu | 8/20 (40%) | 6/20 (30%) |
| TOTAL | 39/100 (39%) | 34/100 (34%) |

Table 4. Protozoa Examination Results on Female Pigeons in Tuban District

| Region | <i>Eimeria</i> sp. | Mixture |
|----------|--------------------|-----------------|
| Widang | 7/20 (35%) | 4/20 (20%) |
| Jatirogo | 7/20 (35%) | 6/20 (30%) |
| Montong | 7/20 (35%) | 5/20 (25%) |
| Soko | 6/20 (30%) | 5/20 (25%) |
| Jenu | 5/20 (25%) | 2/20 (10%) |
| TOTAL | 32/100 (32%) | 22/100 (22%) |

The results of the analysis using the chi-square test on the sex of pigeons and the prevalence of worm egg infection showed a significant difference with p-value = 0.022 ($p < 0.050$). The value above explains that the sex of pigeons affects the prevalence of helminthiasis infection in Tuban district. The high prevalence rate in male pigeons is due to several factors that support endoparasite contamination in the cage which then infects pigeons. Factors supporting endoparasite transmission include contact with other animals adjacent to the pigeon cage such as chickens, cats, mice, and other animals that play a role in the infection of pigeons. Intermediate hosts, such as insects that often set foot on infected pigeons' feed and drinking water, can allow the spread of disease from other animals to pigeons or vice versa (McDougald, 1992). Feeding, cage conditions, and poor sanitation make pigeons susceptible to disease whereas as a result of these conditions parasitic diseases appear first from other diseases (Adejinmi and Oke, 2011).

Comparison of the prevalence of endoparasites in each sub-district in Tuban Regency, the majority showed results that were not significantly different ($p > 0.05$). disease control and prevention. This could be due to the fact that the majority of the cage management of several pigeons breeders in Tuban are very less aware of the importance of cage sanitation, animal husbandry management, disease control, and prevention.

The comparison of the prevalence of worm eggs showed that there was a significant difference in Jenu and Jatirogo sub-districts. This could be due to the geographical location of the Jenu Subdistrict which is located on the coast of Tuban Regency, which causes lower temperature and humidity, compared to the cages in Jatirogo Subdistrict which is located in a higher area, and the management of the cages is very poor so that the cages are not managed properly. Jatirogo sub-district has a very high prevalence rate compared to other sub-districts. In Jatirogo Subdistrict, less attention is paid to the cleanliness of the cage by cleaning the manure in the cage area which is carried out at least once a week, in addition to the cleanliness of the cage, to replace feed and drinking water according to the wishes of the breeder even for days it is not replaced. These are some of the factors that increase gastrointestinal endoparasitic infections.

The prevalence of parasites, in males, is generally higher than in females, this is

influenced by the hormonal status of female pigeons which have the hormone estrogen which can help modulate immune function, while the hormone testosterone can decrease cell-mediated responses to the T-cell mitogen phytohemagglutinin (Fig. Klein, 2004; Oppliger *et al.*, 2004). Another factor is the moving behavior of male pigeons, which flies more, which is 51 times per day, because male pigeons look for their food more often so that male pigeons fly more, compared to female pigeons who are more usual in cages (Kadri *et al.*, 2016).

Chi-square test analysis showed that the results of *Heterakis gallinarum* infection were significantly different ($p < 0.05$) $p = 0.009$. The prevalence of infection was 45%, i.e. 45 positively infected with *Heterakis gallinarum*, from 100 samples of pigeons examined. Examination of feces using native, sedimentation, and floating methods, detected the presence of *Heterakis gallinarum* worm eggs.

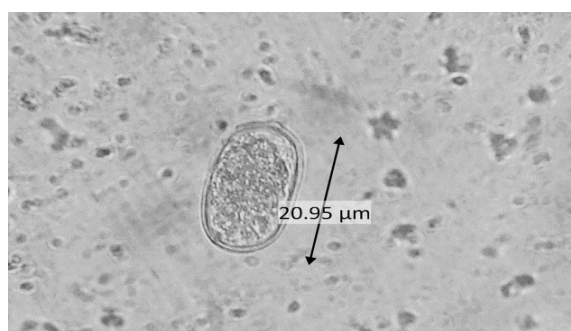


Figure 1. The egg of *Heterakis gallinarum* (400x magnification)

The results of this study are supported by previous research by Eljadar *et al.* (2012) in Libya with a prevalence of 10%. Amin and Kakabwa (2019) in Iraq reported a prevalence of *Heterakis gallinarum* of 1.25%. The results of *Ascaridia columbae* infection were significantly different, namely $p=0.043$ ($P<0.05$). In 100 samples of pigeon feces identified, there were 42 samples that were positive for *Ascaridia columbae* (42%). Identification is based on the morphology of the eggs, which have an oval shape with a smooth and thick shell. The egg size of *Ascaridia columbae* is $60 \times 35 \mu$ (Rahman *et al.*, 2019).

A previous study by (Amin and Kakabwa) 2019 reported the prevalence of *Ascaridia columbae* of 2.82%. Tietz-Marques *et al.*, (2007) reported that 4.91% and 3.27% of *Ascaridia columbae* were detected in southeastern Brazil with mixed infections caused by *Ascaridia columbae* and *Raillietina* sp. Muqorobin *et al.*, (2017) reported in the Surabaya area, the prevalence of *Ascaridia columbae* worms is 5%.

Sampling carried out during the rainy season also affects the level of helminthiasis infection, one of which is *Ascaridia columbae* species, this is due to the decreased immunity of pigeons during the rainy season or cold weather. The rainy season also affects worm eggs, this statement is supported by the explanation of Kusnoto *et al.*, (2011) that eggs containing stage 2 larvae, are able to survive more than 3 months in a shady or protected place, but will die soon if the conditions are dry and the weather is dry. hot. The prevalence of parasitic diseases in pigeons is highest in the rainy season, with an average of 2.5 times higher than in other seasons (Begum *et al.*, 2008).

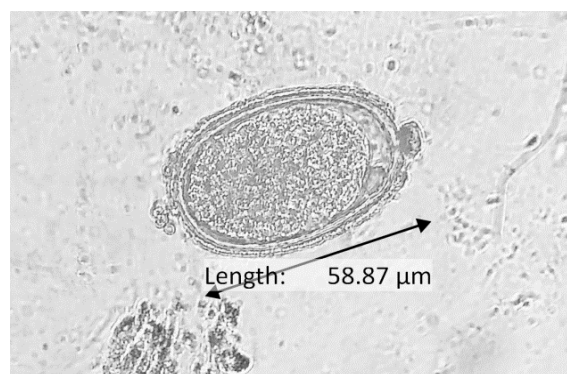


Figure 2. The egg of *Ascaridia columbae* (400x magnification)

Research on 100 samples of pigeons' feces, showed 41 samples of feces that were positive for *Capillaria* sp. With a prevalence of 41%. Identification of *Capillaria* sp. states that the eggs of *Capillaria* sp. Can be identified by observing the formation of a typical "polar plug" (Atkinson *et al.*, 2008).

Eljadar *et al.* (2012) in Libya, found 20% of the 30 pigeons examined were infected with *Capillaria* sp. Amin and Kakabwa, (2019) in Iraq reported the discovery of *Capillaria* sp. A total of 0.62%. Khezerpour and Naem (2013), reported the prevalence of *Capillaria* sp. In domestic pigeons by 10.1%. In a study conducted in Egypt, the prevalence of *Capillaria* sp. is 6% (Bahrami *et al.*, 2011). In Libya, the prevalence of domestic pigeons positive for *Capillaria* sp. is 4% (Alkharigy *et al.*, 2018). However, the prevalence in Tuban Regency is lower than the study by Tanveer *et al.*, (2011) which showed the prevalence of *Capillaria* sp. By 67.2%. *Capillaria* sp. dominate in pigeons where it will cause chronic gastroenteritis and anorexia which causes emaciation to death (El-Dakhly *et al.*, 2016).

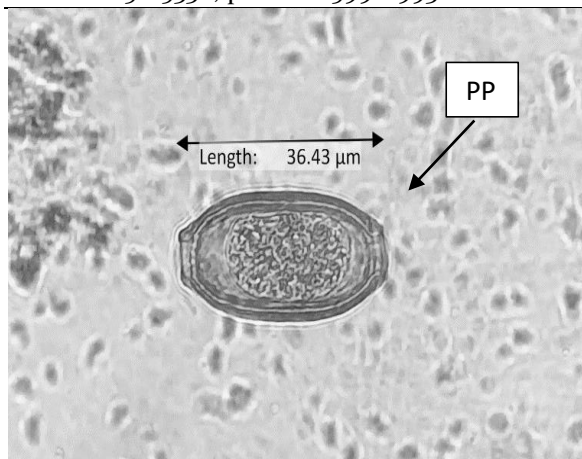


Figure 3. The egg of *Capillaria* sp. There is a polar plug (PP) at both ends of the egg (400x magnification)

The analysis using the chi-square test showed that the protozoan infections were not significantly different, $p=0.123$ ($P>0.05$). The total prevalence of *Eimeria* sp. in pigeons, is not influenced by gender, so male and female pigeons have the same great opportunity by *Eimeria* sp. (Appendix 5). This is due to environmental conditions, a uniform level of sanitation can cause the prevalence of *Eimeria* sp. not so different, in addition to the same age of livestock, management patterns, almost the same feed consumption, can cause the level of body resistance of livestock in generating immunity to infection with *Eimeria* sp. almost the same (Kertawirawan *et al.*, 2019).

In this study, it was found that the form of *Eimeria* sp. is very diverse with the size found being $11.47\mu\text{m}$. The prevalence found in five areas of Surabaya showed that 61% were positively infected with *Eimeria* sp. (Widyaningsih, 2017).

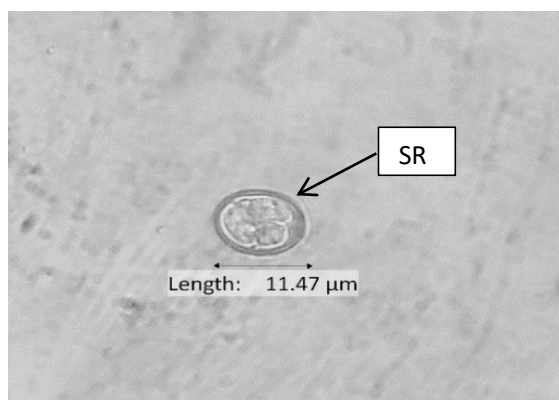


Figure 4. Oocysts of *Eimeria* sp. (SR: Sporocyst) magnification 400x.

Conclusion

Parasite species that infect the digestive tract of pigeons in Tuban Regency are *Heterakis gallinarum* at 45%, *Ascaridia columbae* at 42%, *Capillaria* sp. by 41%, and *Eimeria* sp. By 71%.

The overall prevalence of helminthiasis is 81%, male pigeons have a prevalence of 45% compared to females with a percentage of 36%.

The overall prevalence of protozoal infections is 71%, male pigeons have a prevalence of 39%, while females have a percentage of 32%.

References

- Adang, K.L., Oniye, S.L., Ajanusi, O.J., Ezealor, A.U., Abdu, P.A., 2008. Gastrointestinal helminths of the domestic pigeons (*Columba livia domestica* Gmelin, 1789 aves: Columbidae) in Zaria, northern Nigeria. *Sci. World J.* 3 (1).
- Adejinmi, J.O. and M. Oke. 2011. Gastrointestinal parasites of Domestic Ducks (*Anas platyrhynchos*) in Ibadan South western Nigeria. *Asian J. Poult Sci.* 5 (1): 46– 50.
- AL-jaumeili, A.H., and Aljoburi, M.H. (2015). The parasites that infect the females for domestic fowl (*Gallus Gallus Domesticus*) in the villages of the city of Sharqat, Salah Al-Deen province. *Journal of Tikrit University for Agricultural Sciences.* 15(4), 144-148
- Alkharigy, F.A., A.S. El Naas and A.A. El Maghrbi (2018). Survey of parasites in domestic pigeons (*Columba livia*) in Tripoli, Libya. *Open Vet. J.* 8(4): 360–366.
- Al-Zubaidei, H.H. (2015). Isolation and identification of some ecto and endoparasites on native chickens in Diyala province. *Al-Qadisiyah Journal of veterinary Medicine Sciences.* 14(2), 1-5.
- Amin. O. M., Kakabwa. S. R. 2019. Prevalence of gastrointestinal parasites in domestic pigeons and backyard chickens in Kalar and Khanaqin districts, Iraq. *Journal of University of Garmian.* Hal 1-7.
- Atkinson, C. T., N. J. Thomas and D. B. Hunter (2008). *Parasitic Disease of Wild Birds.* John Wiley and Sons, Inc.
- Badparva E, Ezatpour B, Azami M, Badparva M (2015). First report of birds infection by intestinal parasites in Khorramabad, west Iran. *J. Parasit. Dis.,* 39(4): 720–724.
- Bahrami, A.M., A.L. Monfared and M. Razmjoo (2012). Pathological study of parasitism in

- racing pigeons: An indication of its effects on community health. Afr. J. Biotechnol. 11(59): 12364-12370.
- El-Dakhly, K.M., L.N. Mahrousa and G.A. Mabrouk (2016). Distribution pattern of intestinal helminths in domestic pigeons (*Columba livia domestica*) Turkeys (*Meleagris gallopavo*) in Beni-Suef province, Egypt. J. Vet. Med. Res. 23: 112-120.
- Imura T, Suzuki Y, Ejiri H, Sato Y, Ishida K, Sumiyama D, Murata K, Yukawa M (2012). Prevalence of avian haematozoa in wild birds in a high-altitude forest in Japan. Vet. Parasitol., 183: 244-248.
- Kadri, M. H. M., Septinova, D., and Riyanti, R. (2016). Karakteristik dan Perilaku Merpati Tinggi Lokal Jantan dan Betina. Jurnal Ilmiah Peternakan Terpadu, 4(2): 156-160.
- Klein, S. L. 2004. Hormonal and Immunological Mechanism Mediating Sex Differences in Parasit Infection. Parasite Immunology 26(6-7): 247 - 264.
- Kertawirawan. I. P. A., Budiari. L. G., Sutresna. I. N. 2019. Identifikasi Prevalensi *Eimeria* sp. pada Sapi Bali Di Lahan Marginal dengan Pola Budidaya Semi Intensif. Prosiding Seminar Nasional Kesiapan Sumber Daya Pertanian dan Inovasi Spesifik Lokasi Memasuki Era Industri 4.0. 282-285.
- McDougald, L. R. 1992. Other protozoan diseases in the intestinal tract, In: Hofstad, M. S. ed. *Diseases of Poultry*, 8th edition, Panima Educational Book Agency, New Delhi, India, pp.723-725.
- Muqorobin. A., Yunus. M., Sosiawati. S. M. 2017. prevalensi Helminthiasis pada Burung Merpati (*Columba livia*) Di Surabaya Melalui Bedah Saluran Pencernaan. Journal of Basic Medicine Veterinary. 6(1): 44-50.
- Oppliger, A., Giorgi, M. S., Conelli, A., Nembrini, M., John-Alder, H. B. 2004. Effect of Testosterone on Immunocompetence, Parasite Load, and Metabolism in The Common Wall lizard (*Podarcis muralis*). Can J Zool 82(11):1713-1719.
- Paramitha. R. P., Ernawati. R., Koesdarto. S. 2017. Prevalensi Helminthiasis Saluran Pencernaan melalui Pemeriksaan Feses pada Sapi di Lokasi Pembuangan Akhir (LPA) Kecamatan Benowo Surabaya. Journal of Parasite Science. 1(1): 23-32.
- Fathurohman R., Bakar A., Fitria L. 2014. Analisis Kelayakan Usaha Peternakan Burung Puyuh Di Daerah Pasir Kawung Cileunyi Kabupaten Bandung. Jurnal Online Institut Teknologi Nasional. 3(2): 1-12.
- Hamid, A., E.J Saleh dan S. Fathan. 2015. Pola Tingkah Laku Makan Burung Merpati (*Columba livia*) Jantan yang Dipelihara secara Intensif. Gorontalo. Universitas Negeri Gorontalo. Hal: 1-12
- Rahman. M. M. I. A., Tolba. H.M. N., Abdel-Ghany. H. M. 2019. Ultrastructure, Morphological Differentiation and Pathological Changes of *Ascaridia* species in Pigeons. Advances in Animal and Veterinary Sciences. 7(2): 66-72.
- Regina, M. P., Halleyantoro, R., & Bakri, S. (2018). Perbandingan Pemeriksaan Tinja antara Metode Sedimentasi Biasa Dan Metode Sedimentasi Formol-Ether Dalam Mendeteksi Soil-Transmitted Helminth. Diponegoro Medical Journal (Jurnal Kedokteran Diponegoro), 7(2), 527-537.
- Sivajothi, S. and B.S. Reddy (2015). A Study on the Gastro Intestinal Parasites of Domestic Pigeons in YSR Kadapa District in Andhra Pradesh, India. Journal of Dairy, Veterinary and Animal Research. J. Dairy Vet. Anim. Res., 2(6): 00057
- Sucitrayani PTE. 2012. prevalensi Infeksi Protozoa Saluran Pencernaan pada Kucing Lokal (*Felis catus*) di Denpasar. Fakultas Kedokteran Hewan Universitas Udayana. Denpasar
- Tanveer, M.K., A. Kamran, M. Abbas, M.C. Umer, M.A. Azhar and M. Munir (2011). Prevalence and chemo-therapeutical investigations of gastrointestinal nematodes in domestic pigeons in Lahore, Pakistan. Trop. Biomed. 28(1): 102- 110
- Taylor, M.A., R.L. Coop, and R.L. Wall. 2007. Veterinary Parasitology Third Edition. Blackwell Publishing. Australia. 44, 46, 460-461, 508-509, 655-656, 673, 535-555, 787-791, 836-848.
- Widyaningsih. F., 2017. Prevalensi Protozoa Saluran Cerna Burung Merpati (*Columba livia*) pada Pemeliharaan Ekstensif Dan Intensif di Surabaya [Skripsi]. Fakultas Kedokteran Hewan Universitas Airlangga. Hal. 1, 7, dan 8.