Occurrence of cestodes and comparative efficacy of Typha angustata and sulphadimidine against cestodes in Columba livia domestica (Domestic Pigeon)

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Abstract
The occurrence of intestinal parasites of Columba livia domestica has been on the increase, leading to high economic and production losses with more fatal cases. This study was designed to investigate the prevalence of cestodes in pigeons and determine the efficacy of Typha angustata extract and sulphadimidine against these cestodes in the domestic pigeon. A total of 30 pigeons were examined. 18 (60%) pigeons were found infected with only one type of cestode species (Raillietina spp.). The difference in prevalence between males and females was statistically significant ($\chi^2 = 8.167$, $p = 0.004$). The mean EPG count in group A (treated with T. angustata extract) before treatment and after treatment was 176 ± 4.33 and 155 ± 4.24, respectively. In group B (treated with sulphadimidine), the mean EPG calculated before treatment and after treatment was 184 ± 6.74 and 35 ± 3.53, respectively. The efficacy at day 28 of T. angustata and Sulphadimidine was 11.93% and 80.97%, respectively. It was concluded on the basis of the EPG and efficacy data that T. angustata extract had low efficacy against raillietiniasis, while as sulphadimidine, which is also used before to treat different intestinal parasites, had a good efficacy against raillietiniasis. Further studies are required to know the prevalence of other gastrointestinal parasites in pigeons and efficacy of different medicinal plants against such parasites.

1. Introduction
Pigeons are present almost in every part of the globe (Marques et al., 2007). It is estimated that 170–340 million pigeons reside in cities worldwide (Haag-Wackernagel and Bircher, 2010). Many health issues can affect pigeons, but infestations with parasites play an essential part. Many ecto- and endoparasites, associated with several pigeon diseases, are found on the skin and various internal organs (Parsani et al., 2014). Helminths have been involved in causing infection and higher mortality in domestic pigeons. They are considered as one of the critical weaknesses in the production of commercial pigeons in Pakistan (Tanveer et al., 2011). Roundworms, stomach wall worms, hairworms, gape-worms, strongyloids, and tapeworms are the common worms reported in pigeons. Among cestodes, Raillietina spp. is the most prevalent parasite reported in pigeons. Its extreme infestations cause droopiness and weight loss (Kamal et al., 2020).

Various anthelmintics was used for the treatment of helminths infections in birds. The most widely used anthelmintic is albendazole and fenbendazole (Bowman et al., 1995; Tucker et al 2007)). Ssenyonga (1982) reported that fenbendazole efficacy is 100% against helminths parasites of birds. Albendazole has very adverse side effects and induce liver injury, even in small doses (Pliou and Dumitrascu, 2021). Sulphadimidine is used regularly in chicken...
husbandry for its wide-spectrum activities toward bacterial and coccidian infections (Khan et al., 2021). However, the therapeutic efficacy of sulphadimidine on helminths infection in pigeons was not yet investigated. Therefore, sulphadimidine was used in this study to find out its efficacy against cestodes.

Recently, there has been a growing interest in ethnoveterinary medicine worldwide. This change responds to the development of animals free from synthetic chemical additives in the developing world and the need to find new beneficial substances of natural origin with relatively low toxicity to humans and animals (Guarrera, 1999, Gasbarre et al., 2001). In traditional literature in India and China, T. angustata is the most common medicinal herb used for various medicinal properties. It is a member of the Typhaceae family. It is an annual plant growing in a pond or on the side of a river in shallow water. It is 3–6 feet in height and growing straight with its leaves and stems. The thickness of its leaf is 5–12 mm. The leaves are used for diuretic purposes (Duke and Ayensu, 1985). It is used for hematemesis, nose-bleeding, hematuria, dysmenorrhea, uterine bleeding, abdominal postpartum pain, scrofula, gastralgia and abscesses. The root material is diuretic and astringent (Chopra et al., 1986). It contains various ingredients, i.e., flavonoids, tannins, sterols, and triterpenes. In the stems and flowering tips, flavonoids are present, i.e., quercetin, naringenin, isorhamnetin-3–0-neohesperidosine, isorhamnetin, kaempferol-3–0-neohesperidosine, isorhamnetin-3–0-rutinoside, β-sitosterol, lanosterols, and cholesterol are contained in the sterols. (Kumar et al., 2013). In Pakistan very less work has been done with regard to the anthelmintic properties of indigenous medicinal plants in poultry. Therefore, this plant was used in this study to know its efficacy against cestodes in pigeons.

Keeping in view the background information the current research was designed to study the occurrence of cestode infections in pigeons of District Dir Lower, Khyber Pakhtunkhwa, Pakistan and determine the anticestodal activity of T. angustata and sulphadimidine in Columba livia domestica (domestic pigeon).

2. Materials and methods

2.1. Study area

This study was performed following the international guiding principles for biomedical research involving animals, and approval was taken from the animal ethics committee of the Abdul Wali Khan University Mardan.

2.2. Study area

The present study was carried out in District Dir Lower, Khyber Pakhtunkhwa, Pakistan. Its geographical coordinates are 34° 33’ 56” North, 71° 55’ 52” East. This area is characterized by heavy rainfall in winter and hot weather in summer. Temperature ranges from 12 °C to 40 °C. The map of the study area was prepared using ArcMap 10.5 software (Fig. 1).

2.3. Pigeons’

Thirty (30) domestic pigeons (Columba livia domestica) of both sexes were purchased from local markets of District Dir lower (Fig. 1). The history, sex, and age of the pigeons were recorded. They were kept in wide and well-ventilated animal house chambers at the University of Malakand, Khyber Pakhtunkhwa, Pakistan. The pigeons were fed on freshwater with wheat and grains. The specimens were placed in this environment for acclimatization for two weeks before the beginning of the experiment.

2.4. Preparation of plant extract

The herb T. angustata were collected from the side of the river Panjkora, Timergara, Dir lower. The plant was botanically identified in the Department of Botany, University of Malakand, Khyber Pakhtunkhwa, Pakistan. Whole plant of T. angustata were cut off, rinsed with fresh water, and dried under a shed for two weeks.
The shed dried plant was mechanically ground in an electric chopper to get fine powder forms.

During extract preparation, 100 g of powdered T. angustata was soaked in 500 ml de-ionized water. The soaking continues for three days with occasional shaking. The soaked powdered plant was filtered through muslin cloth for removing debris. The filtrate was stored at 4 °C in the refrigerator to avoid the fungal attack.

2.5. Sulphadimidine (Commercially available drug)

This drug was purchased from a veterinary shop at Lower Dir. This drug was in tablet form. Each tablet was 350 mg.

2.6. Grouping of birds

Firstly, 30 pigeons’ droppings were collected and examined for cestodes eggs. 18 pigeons were found infected. These pigeons were then divided into four groups (A, B, Cp and Cn). For each individual’s identity in a group, different coloured foot rings were used and then birds were weighted by manual weight balance and placed in separate cages. The experimental details are given in Table 1.

2.7. Collection and laboratory examination of droppings samples

Dropping samples were collected (5–50 g each) at day 0 (before treatment), day 7, 14, 21 and 28 (after treatment). The samples were collected in a plastic container, preserved in 10 per cent formalin solution, and transferred to the laboratory of parasitology, University of Malakand Chakdara, for qualitative and quantitative examination.

Direct microscopy and flotation techniques were used for qualitative analysis of dropping samples and for quantitative analysis, the McMaster methodology was performed as per the standard protocols. The protocols laid down by William (2001), Dranzoa et al. (1999) and Soulsby, (1982) for Direct microscopy, Flotation method and McMaster method, respectively were followed.

2.8. Collection and examination of gastrointestinal tracts

Each pigeon was placed in a vacuum chamber containing cotton wool soaked with 10 ml of chloroform for 6 to 7 min after the end of the trail. The anaesthetized pigeons were then dissected. Each of the pigeon was slit open from the cloaca to the neck region. The visceral organs like gizzard, small and large intestines, and liver were removed from the body.

The parasites were only present in the large intestines and were gently removed in Petri dishes containing 70% alcohol. The specimens were then processed and permanent mounts of the parasites were made by following the standard protocol of Al Quraishy et al. (2019). The slides were then examined under the microscope and the parasites were identified using standard morphological keys (Cheng, 1973; Soulsby, 1982; Ruprah et al., 1986). The photomicrographs were prepared using an automatic photomicrographic camera mounted on a trinocular microscope (Labomed Labo America, Inc USA) in the laboratory of Zoology, University of Malakand, KPK, Pakistan. The silent morphological features of the identified cestode are: Total body measurement varies from 17.65 mm to 60.80 mm in length and 0.4 mm to 1.26 mm in width. Scolex is simple, wider than long. Rostellum with a row of hammer shaped hooks. Sucker is simple. Immature, mature and gravid segments are wider than long. Gravid segments are also much wider than mature segments. The uterus is broken into egg capsules, each containing several eggs (Fig. 2). The prepared slides were labelled and deposited in Department of Zoology, University of Malakand, for future reference.

3. Results

3.1. Prevalence

A total of 30 domestic pigeons were examined. 60% of pigeons were found infected with Raillietina spp. tapeworm (Table 2). In the present study 82.35% males and 30.77% females were found positive for Raillietina spp. The difference in prevalence between males and females was statistically significant ($\chi^2 = 8.167$, $p = 0.004$) (Table 2). On gastrointestinal tract examination, a total of 151 Raillietina spp. cestodes were recovered from all the birds. The mean parasitic burden among infected pigeons was $8.38 \pm 2.43$.

3.2. Dropping egg count

The mean egg per gram (EPG) of droppings was calculated before and after treatment in groups A, B, Cp, and Cn. Group A, which was treated with T. angustata exhibited the mean EPG before treatment on day 0 as $176 \pm 4.33$. EPG after treatment at day 7, 14, 21, and 28 was $167 \pm 8.13$, $165 \pm 5.44$, $159 \pm 6.32$, and $155 \pm 4.24$, respectively. Before treatment and after treatment, the mean EPG before treatment and the mean EPG after treatment was 176 ± 4.33 and 155 ± 4.24, respectively (Table 3).
Group B was treated with sulphadimidine and the mean EPG calculated before treatment on day 0 was 184 ± 6.74. EPG after treatment at day 7, 14, 21, and 28 was 155 ± 3.37, 126 ± 3.55, 84 ± 4.55, and 35 ± 3.53, respectively. The mean EPG count before treatment and after treatment was 184 ± 6.74 and 35 ± 3.53, respectively (Table 3).

Group Cp was untreated positive control, and the mean EPG was 162 ± 8.87 at day 0. EPG at day 7, 14, 21, and 28 was 175 ± 4.44, 179 ± 7.22, 168 ± 5.36, and 187 ± 1.33, respectively. EPG count on day 28 was slightly increased, while in the Cn group, no cestode egg was noted from day 0 to day 28 (Table 3).

3.3. Efficacy

The efficacy of *T. angustata* was calculated against *Raillietina* spp. for four weeks. The per cent efficacy calculated on day 7, 14, 21, and 28 were 5.11%, 6.25%, 9.65%, and 11.93%. The lowest efficacy was noted on day 7, while the highest efficacy was noted on day 28. When the quantity of dose increased in the next week, the efficacy slightly increased (Table 4).

The efficacy of Sulphadimidine was also calculated against *Raillietina* spp. for four weeks. The percent efficacy calculated at day 7, 14, 21, and 28 were 15.76%, 31.52%, 54.34% and 80.97%. The lowest

| Groups | Treatment   | Efficacy (%) |
|--------|-------------|--------------|
|        |             | Day 7        | Day 14       | Day 21       | Day 28       |
| A (n = 6) | Typha angustata | 5.11%          | 6.25%           | 9.65%           | 11.93%          |
| B (n = 6) | Sulphadimidine | 15.76%          | 31.52%          | 54.34%          | 80.97%          |

Table 2
Prevalence of *Raillietina* spp. parasites in male and female pigeons.

| Sex       | Pigeons Examined | Pigeons Infected | Prevalence % | Chi-Square | P-value |
|-----------|------------------|------------------|--------------|------------|---------|
| Male      | 17               | 14               | 82.35        | 8.167      | 0.004*  |
| Female    | 13               | 4                | 30.77        |            |         |
| Total     | 30               | 18               | 60.00        |            |         |

Table 3
Mean EPG in different groups observed on different days.

| Groups | Treatment     | Mean egg per gram of droppings (Mean EPG) |
|--------|---------------|------------------------------------------|
|        |               | Day 0         | Day 7         | Day 14        | Day 21        | Day 28        |
| A (n = 6) | Typha angustata | 176 ± 4.33    | 167 ± 8.13    | 165 ± 5.44    | 159 ± 6.32    | 155 ± 4.24    |
| B (n = 6) | Sulphadimidine | 184 ± 6.74    | 155 ± 3.37    | 126 ± 3.55    | 84 ± 4.55     | 35 ± 3.53     |
| Cp (n = 6) | Nil            | 162 ± 8.87    | 175 ± 4.44    | 179 ± 7.22    | 168 ± 5.36    | 187 ± 1.33    |
| Cn (n = 12) | Nil            | 0             | 0             | 0             | 0             | 0             |

Cp = Control Positive; Cn = Control Negative.
efficacy was noted on day 7, while the highest efficacy was noted on day 28. When the quantity of dose increased in the next week, the efficacy increased significantly (Table 4).

5. Conclusion

Based on the present study, it is concluded that Raillietina spp. is the most prevalent parasite of domestic pigeons in Lower Dir, Khyber Pakhtunkhwa, Pakistan. Raillietina spp. Usually, parasitize the avian fauna of wide geographical regions.

The data suggested that T. angustata extract is less effective against raillietiniasis, while sulphadimidine is more effective to treat raillietiniasis. Further studies are warranted to know the prevalence of various parasitic diseases in pigeons along with the effective control strategies.

Declaration of Competing Interest

All authors declare no conflicts of interest. All authors listed in the manuscript contributed and attest to the validity and legitimacy of the data and its interpretation and agree to its submission to your journal.

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