Introduction

In Kano State, the domestic pigeon (Columba livia domestica) is reared for meat production by some households, thereby contributing significantly to the protein need of the local populace [1]. Although they are kept in lofts and fed with leftovers by owners and neighbouring communities, they often fly out to scavenge for more supplements including various species of earthworms, dung beetles and ants [2,3], and can therefore be considered as feral [4]. They harbour a number of infective stages of various intestinal parasitic diseases, including coccidiosis [5]. Coccidiosis is a ubiquitous disease caused by protozoan parasites of the genus Eimeria, a complex and diverse group of protozoan parasites [6]. There are four species of high importance in pigeon: E. columbae, E. colubrarum, E. labbeana (most pathogenic) and E. tropicalis [7]. Pathogenic Eimeria causes severe enteric disease resulting in heavy financial losses in the global poultry industry, including pigeons [6]; it is often characterised by fluffy feathers, anorexia and watery diarrhoea with mucus, and results in mortality [8].

Previous studies have detailed the occurrence of coccidiosis globally [5–11] and in some parts of Nigeria [12–14]. However, there is paucity of information regarding coccidiosis in domestic pigeons in Kano State.

The present study determines the prevalence of coccidiosis in pigeons kept in the Kano central metropolis.
Kano State lies in the Sudan savannah zone of Nigeria (12°12'N 8°3'E) and is bordered by Plateau, Bauchi and Katsina States to the North and East. It has a Sudan-type climate, with a mean temperature of 25°C. The wet season is from May to mid-October, with an annual rainfall of 1,000 cm³, whilst the dry season extends from mid-October of one calendar-year to mid-May of the next [1,15–16].

The study was conducted in 12 Central Local Government Areas of Kano State (Fig. 1). In total, 144 pigeons, comprising 72 males and 72 females, were examined during the dry (February to April, 2007) and wet (June to August, 2007) seasons. The pigeons were divided into three groups according to age: squabs (0–4 weeks), squeakers (5–8 weeks) and youngsters (9+ weeks), each group including 48 pigeons [1,17] (Fig. 2).

The pigeons were slaughtered and their intestinal contents were examined for *Eimeria* oocysts in the Faculty of Science Laboratory, Bayero University, Kano, Nigeria. In the laboratory, the sampled pigeons were necrotized and their intestines exposed as described by Fatihu et al. [18]. Faecal samples were collected from the intestines and subjected to parasitological analysis using the formol-ether concentration technique. Briefly, one gram of faeces was suspended in 10 ml of 10% formaldehyde solution and thoroughly mixed using a glass rod. The suspension was strained through a funnel covered with a gauze pad into a centrifuge tube. Following this, 3 ml of ether was added and the suspension mixed for one minute. The tubes were then centrifuged for two minutes at 2000 rpm. After discarding the supernatant, the sediment was

### Table 1. Prevalence and intensity of infection with *Eimeria* spp. oocysts identified in pigeons from selected Local Government Areas of Kano State

<table>
<thead>
<tr>
<th>S/No.</th>
<th>Local Government Area</th>
<th>Number sampled</th>
<th>Intensity of infection</th>
<th>Number infected</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dala</td>
<td>12</td>
<td>++</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>Dawakin Kudu</td>
<td>12</td>
<td>+</td>
<td>1</td>
<td>8.33</td>
</tr>
<tr>
<td>3</td>
<td>Fagge</td>
<td>12</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>Gezawa</td>
<td>12</td>
<td>++</td>
<td>2</td>
<td>16.67</td>
</tr>
<tr>
<td>5</td>
<td>Gwale</td>
<td>12</td>
<td>++</td>
<td>2</td>
<td>16.67</td>
</tr>
<tr>
<td>6</td>
<td>Kumbotso</td>
<td>12</td>
<td>++</td>
<td>2</td>
<td>16.67</td>
</tr>
<tr>
<td>7</td>
<td>Minjibir</td>
<td>12</td>
<td>+++</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>8</td>
<td>Municipal</td>
<td>12</td>
<td>+++</td>
<td>5</td>
<td>41.67</td>
</tr>
<tr>
<td>9</td>
<td>Nassarawa</td>
<td>12</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>10</td>
<td>Tarauni</td>
<td>12</td>
<td>+++</td>
<td>4</td>
<td>33.33</td>
</tr>
<tr>
<td>11</td>
<td>Tofa</td>
<td>12</td>
<td>+++</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>12</td>
<td>Ungogo</td>
<td>12</td>
<td>+++</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>144</td>
<td></td>
<td>28</td>
<td>19.44</td>
</tr>
</tbody>
</table>
examined by taking a drop with a Pasteur pipette and depositing it on a glass slide. The slide was examined microscopically for *Eimeria* oocysts at ×10 and ×40 as described by Murray et al. [19]. The sex and age of the birds, as well as the collection site, were recorded as described by Urquhart et al. [20].

The intensity of coccidial infection was graded on a scale of + to +++ (+ mild, + + moderate and + + + severe) of oocysts per gram (OPG) of faeces.

Differences in the numbers of oocysts between the pigeons according to sex and season were compared using the Student’s t-test. Differences were regarded as significant at p<0.005.

**Results**

In total, 19.44% of examined pigeons (28 of 144) were infected with *Eimeria* spp. oocysts. The oocysts were observed to be widespread across all the studied Local Government Areas of Kano State, except Fagge and Nassarawa (Table 1). *Eimeria* spp. oocysts were most predominant in squabs (27.08%), followed by squakers (20.83%) and youngsters (10.42%) (p<0.05). The prevalence was higher in females (20.83%) than in males (18.06%) (p<0.005) (Table 2), and during the wet season (8.96%) than the dry season (5.98%) (p<0.05).

**Discussion**

Coccidiosis, one of the most common parasitic infections of poultry, is considered an important parasitic disease of pigeons causing heavy economic losses in the pigeon industry [11]. In this study, *Eimeria* spp. was found to infect pigeons of all ages and sexes with an overall prevalence of 19.44%. A similar high prevalence was recorded in pigeons in the province of Jos by Pam et al. [12] and in Owerri by Opara et al. [14]. This could be attributed to the free-range and semi-intensive practices of rearing pigeons in parts of Nigeria, which expose the birds to substantial numbers of oocysts [13]. However, no clinical signs were observed as only the sub-clinical form occurred most frequently. After first ingesting some quantities of oocysts, the pigeons develop immunity to infection by the stimulation of endogenous defence mechanisms, without visibly succumbing to the disease. With this protection, immunity is reinforced by constant ingestion of low levels of oocysts; the birds live in a kind of equilibrium with the parasites, which also protects them against severe intestinal disease [21]. While squabs suffer the greatest losses to the clinical form of the disease, characterised by diarrhoea and sudden death, mortality may occur in birds as old as three to four months [22], and may occasionally be seen where birds are reared intensively and under poor hygiene conditions. Older birds only serve as carriers and remain apparently healthy [11]. Higher infection rates were reported in Hyderabad, India, 32.7% (121/370) [5], South Khorasan, Iran, (40.19%) [23] and Chanhai, China, (55.2%) [10]. In addition, infection has been observed in 89–93% of squabs and squeakers and

<table>
<thead>
<tr>
<th>Sex</th>
<th>Number of examined</th>
<th>Number of infected</th>
<th>Prevalence (%)</th>
</tr>
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<tbody>
<tr>
<td>Male</td>
<td>72</td>
<td>13</td>
<td>18.06</td>
</tr>
<tr>
<td>Female</td>
<td>72</td>
<td>15</td>
<td>20.83</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squabs (0-4 weeks)</td>
<td>48</td>
<td>13</td>
<td>27.08</td>
</tr>
<tr>
<td>Squeakers (5-8 weeks)</td>
<td>48</td>
<td>10</td>
<td>20.83</td>
</tr>
<tr>
<td>Youngsters (9 weeks +)</td>
<td>48</td>
<td>5</td>
<td>10.42</td>
</tr>
</tbody>
</table>

Fig. 2. Pigeons in their natural environment (loft) from Municipal Local Government Area of Kano State A – squabs; B – squakers; C – youngsters
63–55% of youngsters in Poland [24]. Further investigations revealed that, despite general good hygiene, conditions in the loft (Fig. 2) such as the type of litter and stocking density, are conducive to the proliferation of parasites and establishment of re-infection from the floor. In addition, attempts to rear birds in such coccidian surroundings were more likely to fail or result in severe infections once the birds were subsequently exposed [21].

In conclusion, our findings indicate that coccidiosis of domestic pigeons is prevalent in Kano State, with the potential to compromise the health status of the pigeons living there, and that constant veterinary surveillance is required to prevent economic losses in the pigeon breeding industry. The results of this study also provide basic guidance for the establishment of efficient control strategies against coccidiosis in domestic pigeons.

References


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