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Ectoparasite Infestations among Domestic Rats (*Rattus Rattus*) and their Zoonotic Implications in Kano Metropolis, Kano State, Nigeria

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Abstract

Rodents survive and proliferate in close association with humans in households, agricultural and commercial places, with approximately 2,277 species, out of which 217 have been identified as reservoirs for zoonotic infections. This study aimed at assessing the prevalence of ectoparasites infestations among domestic rats (*Rattus rattus*) and zoonotic implications within Kano Metropolis. A live trapping system was used to capture domestic rats from residential houses of Kano metropolis. Ectoparasites were collected by combing the fur on to a white plain sheet of paper. Out of the 400 rats examined, 271 (67.8%) of rats were infested with at least a single ectoparasite. Ticks had the highest (23.1%) prevalence of ectoparasites among rats while Bugs had the lowest prevalence with 5.0%. Fagge Local Government Area recorded the highest prevalence of ectoparasites among rats (81.3%) while the least prevalence (54.8%) occurred in Kano Municipal Council. Statistically, there is no significant difference in the prevalence of ectoparasites based on location (X^2= 0.31645, P>0.05). Fleas and Ticks, were the most prevalent ectoparasites, with prevalence of (29.2%) and (26.4%) in Fagge and Dala Local Government Areas respectively, while the lowest prevalence was exhibited by bugs with a prevalence of (0.0%) in Kano Municipal, Nassarawa, Ungoggo and Kumbotso Local Government Areas respectively. Multiple infections with various ectoparasites also occur among the rats and this was not found to be significant (X^2= 2.40434, P> 0.05). The study shows a great association between domestic rat population and spread of parasitic diseases in the study area. The study calls for the use of rodenticides and awareness campaign to reduce human exposure to rats. Further molecular and immunological investigations are also encouraged, for better understanding of cross-transmission of zoonotic pathogens and development of effective control strategies.

Introduction

Rodentia is the largest order of mammals, with over 2,277 species (Wilson & Reeder, 2005) comprising approximately 42% of global mammalian biodiversity, this makes them to be nearly worldwide in distribution (Rabiee et al., 2018). An estimated 1,700 species of rodent belonging to three different families; Muridae (e.g. *Mus spp*., *Rattus rattus diardii*, and *Rattus norvegicus*), Microtidae (e.g. *Microtus spp*.), and Sigmodontidae (e.g. *Peromyscus spp*.) were reported to be commonly found in Africa, Eurasia, and Australia, respectively. The families Microtidae and Sigmodontidae are also found in America apart from Eurasia and Australia (Steven, 2006). *Rattus norvegicus*, *Rattus rattus*, and *Mus musculus* are the most common rodent species in urban areas due to their remarkable acclimation to being in close proximity to people and also their rapid reproduction (Mustapha et al., 2019).

Despite the fact that rodents are important in many ecosystems, they act as reservoir hosts for important human parasitic diseases and consequently, hosts to a number of ectoparasites such as lice, mites and ticks that can transmit viral, bacterial and protozoan parasites to man and animals. In addition, they can harbour many protozoans and helminthic endoparasites (Okoye & Obiezue, 2008), in addition rodents are important sources of nuisance to mankind and transmit diseases and eventually pose a health risk to humans (Seifollahi et al., 2016). However, out of 2277 rodent species worldwide, 217 have been identified as reservoirs for zoonosis, including viral, bacterial and fungal parasitic infections (Luna et al., 2020).

After bats, rodents are considered to be the most significant animals that carry zoonotic pathogens (Luis et al., 2013). Since the middle ages, rodents have contributed to the spread of many disease pandemics, such as plague, murine typhus, and leishmaniasis (Islam et al., 2021). They are easily infected by several live parasitic agents, because of their life styles, habitats and life as close communities. Therefore, they can be major sources of infectious agents for humans (Kataranovski et al., 2008). Rodents carry different ectoparasites, which act as vectors of these pathogens (Meerburg *et al*., 2009). There are many zoonotic pathogens, such as *Hymenolepis diminuta*, *Bartonella* sp., *Coxiella burnetti*, and *Rickettsia* sp., which have been identified from rodent-borne fleas, mites, and ticks (Christou et al., 2010). Rodents carry many ectoparasites, such as lice, fleas, ticks, and mites (Meerburg et al., 2009), that are associated with low socioeconomic status, war, famine, climatic events (e.g., floods), and environmental changes, facilitating the transmission of pathogens among the human and animal populations (Semenza & Menne, 2009).

Several rat and rodent species exist in and around Kano State, Nigeria. The main man ones recorded are: Roof/ship rat (*Rattus rattus*), Natal multimammate rat (*Mastomys natalensis*), Nile rat (*Arvicanthis niloticus*). Other rodents found in northern Nigeria are: Nigeria mole rat (*Fukomys foxi*), common rofous-nose rat (*Oenomys hypoxanthus*), Greater cane rat (*Thryonomys swinderianus*) locally called grasscutter- "*Gegbi*" in Hausa language (Rabiu, 2017). Rats are considered to be the most predominant species of rodent within the geographical regions of Kano metropolis, where it creates nuisance disturbances to the citizens of the city. Although, a small subset of the population living in this city consumes rat meat (Ladele *et al*., 1996), the organism might play a significant public health importance in disease transmission via vectors, contaminations, as well as ecological interactions with residents of the city.

There is a paucity of published research on the prevalence of ectoparasites on *Rattus rattus* in Kano metropolis. Therefore, this study aimed to assess the prevalence of ectoparasites on *Rattus rattus* from Kano metropolis, Kano State, Nigeria. However, this study is significant to highlight the risk factors associated with ectoparasite infestation of domestic rats within the study area.

Materials and Methods

Study area

The study was carried out in Kano metropolis, which represents the state capital, consisting of eight Local Government Areas. The area lies between latitude 12° 25′ and 12° 40′N and longitudes 8° 35′N and 8° 45′E (Figure 1). It shares boarders with Madobi and Tofa Local Government Areas to the Southwest, Gezawa Local Government Areas to the East, Dawakin Kudu Local Government Areas to the South East, and Minjibir Local Government Areas to the North East (Hafizu et al., 2023). Kano metropolis is the third largest town in Nigeria after Lagos and Ibadan. It has a population of 2,826,307 people (NPC, 2006) with Hausa language as the native and most widely used language in the area (Hafizu et al., 2023). Kano State as a whole, is historically a commercial and agricultural State, also one of the most developed industrial cities in Nigeria, hence it is known as the centre of commerce (Olofin et al., 2008).

Ethical Consideration

We conducted the research following the declaration of Helsinki. The study objective was clearly explained to the Household heads and informed consent was obtained from them before proceeding to set the rat traps for the study.

Trapping of Domestic Rat

A total of 400 domestic rats were caught using a live-trapping system. A cage-trap was locally provided for the purpose of the study. This was done following the protocols provided by Christophe et al., (2011). The traps were labelled according to the respective trapping sites. The traps were baited with feed (Groundnut or fish) and checked early in the morning (Abdullahi & Tijjani, 2020). The animals were transported to the laboratory for further examination.

Euthanization

Euthanization was done following the method described by Leary et al. (2020). In the laboratory, each animal was euthanized in a bell jar containing cotton wool soaked with chloroform. The bell jar was closed and allowed to stay for couples of minutes. Following successful euthanization, the animal was removed and placed on a clean white A4 paper for collection of ectoparasites.

Collection of Ectoparasites

The ectoparasites were collected with a soft fine-brush. And the fur of each rat was thoroughly combed on to a white A4 plain sheet of paper using a soft-brush. Different brushes were used for each individual rat in order to have good results. The softer body parts of the rodent, such as the belly, ear, and tail regions, were further examined using hand lenses (Christophe et al., 2011; Abdullahi & Tijjani 2020; and Gebrezgiher et al., 2023).

Identification of Ectoparasites

Immediately after collection, all ecto-parasites that fell on the white A4 sheet were suspended under a dissecting microscope (Abdullahi & Tijjani, 2020) and identified based on their morphology. Characteristic features were based on taxonomic keys of Mathison and Pritt (2014).

Statistical analysis

Data generated in this study was entered into and analyzed using mini-tab software where the proportion of infested animals was summarized using descriptive statistics, specifically prevalence, and percentages and chi-square test was applied to assess the associations between parasites and the study variables. Level of significance was set at p value < 0.05 as statistically significant.

Results

Out of the 400 domestic rats examined for ectoparasites infestations, a total of 271 (67.8%) samples were observed to be positive for at least single ectoparasite (Figure 2). During the study, Ticks, fleas, lice, bugs and mites were the ectoparasites commonly detected. The result also showed that Fagge Local Government Area recorded the highest (81.3%) prevalence of ectoparasites among domestic rats while the least prevalence (54.8%) was recorded from Kano Municipal Area Council.

The distribution of ectoparasites infestations among domestic rats (*Rattus rattus*) in Kano metropolis is shown in table 1. The result indicated that ticks had the highest (23.1%) prevalence of ectoparasites while Bugs had the lowest prevalence with 5.0%. The result also showed that highest prevalence of ticks was recorded in Dala Local Government Area, with 26.4% samples testing positive. The prevalence of fleas was higher in the Fagge Local Government Area, with prevalence rate of 29.2%. Fagge showed the Local Government Area showed the highest prevalence of lice with 27.1% testing positive. Mites recorded highest (25.0%) prevalence in Kumbotso, Gwale, Dala; while Bugs had the highest (13.5%) prevalence in Tarauni Local Government Area and a lower prevalence of (0.0%) in Kano Municipal, Nassarawa, Ungoggo and Kumbotso Local Government Areas respectively. However, there was no significant difference in the prevalence of ectoparasites in a single domestic rat in relation to different Local Government Areas (P> 0.05).

Moreover, the result in table 1 indicated that combination of ticks and fleas was observed in Gwale, Nassarawa, Ungoggo, Tarauni, and Kumbotso, with prevalence rates of 14.3%, 6.3%, 5.4%, 3.8%, and 1.9%, respectively. Double infestations of domestic rats with lice and fleas were most prevalent in Gwale, Kumbotso, Nassarawa, and Dala, with prevalence rates of 6.1%, 5.8%, 4.2%, and 3.8%, respectively. A lower prevalence was observed in Fagge, Tarauni and Ungoggo, with 2.1%, 1.9% and 1.8% positive samples respectively. In contrast, combined infestations with ticks and lice were observed, with Gwale showing the highest prevalence at 10.2%, followed by Fagge and Ungoggo, with 4.2% and 3.6% positive samples. Notably, lower prevalence was recorded in Nassarawa, Tarauni, and Kumbotso, with only 2.1%, 1.9% and 1.9% of samples testing positive, respectively. There was no significant difference in the multiple infestations of ectoparasites among domestic rats (P> 0.05).

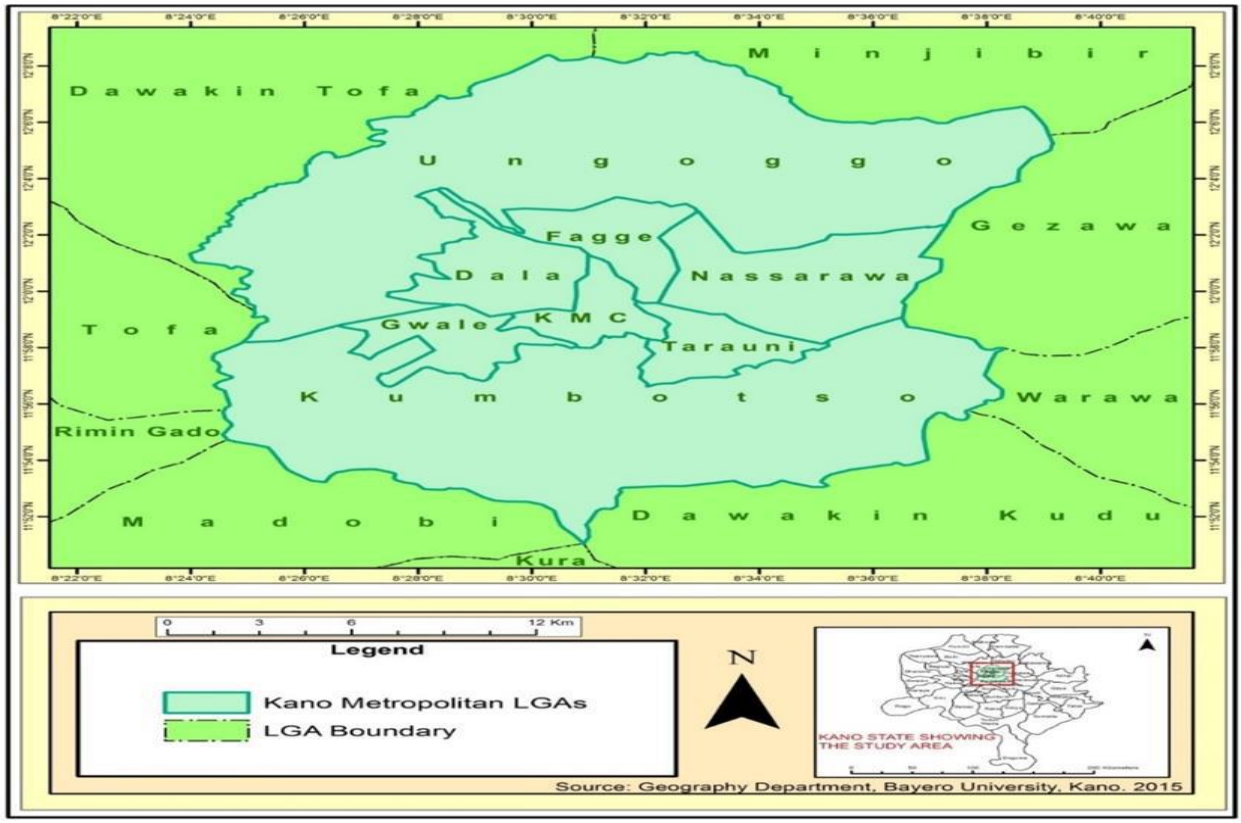

Figure 1: Map of Kano Metropolis and its Boundaries

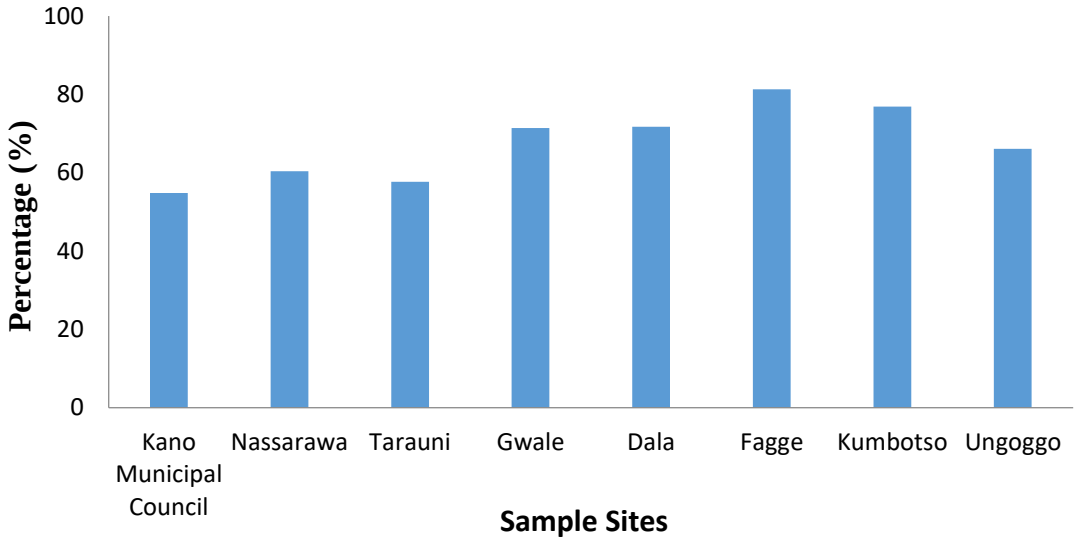

Figure 2: Overall Prevalence of Ectoparasites among Domestic Rats (*Rattus rattus*) in Kano Metropolis

Rattus rattus

Xenopsylla cheopis

Ornithonyssus bacoti

Ctenocephalides felis

Figure 3: A Captured Rat and Some Ectoparasite species Recovered from domestic rats

Table 1: The Distribution of Ectoparasites Infestations among Domestic Rats (*Rattus rattus*) in Kano Metropolis

		Single Infestations (No. (%) Positive) X^2 = 0.31645 p value = 0.57375					
Sample Sites	(n)	Ticks	Fleas	Lice	Mites	Bugs	Total
Kano Municipal Council	42	11(26.2)	4(9.5)	3(7.1)	5(11.9)	0(0.0)	23(54.8)
Nassarawa	48	7(14.6)	4(8.3)	5(10.4)	10(20.8)	0(0.0)	29(60.4)
Tarauni	52	10(19.2)	9(17.3)	4(7.7)	0(0.0)	7(13.5)	30(57.7)
Gwale	49	12(24.5)	9(18.4)	8(16.3)	0(0.0)	6(12.3)	35(71.4)
Dala	53	14(26.4)	8(15.9)	7(13.2)	5(9.4)	4(7.5)	36(67.9)
Fagge	48	9(18.8)	14(29.2)	13(27.1)	0(0.0)	3(6.3)	39(81.3)
Kumbotso	52	10(18.2)	9(17.3)	8(15.4)	13(25)	0(0.0)	40(76.9)
Ungoggo	56	12(21.4)	7(12.5)	13(23.2)	5(8.9)	0(0.0)	37(66.1)
Total	400	85(21.3)	64(16.0)	61(15.3)	38(9.5)	20(5.0)	271(67.8)

		Mixed Infestations [No. (%) Positive] X^2 = 2.40434 p value = 0.12100			
Sample Sites	(n)	Ticks and Fleas	Lice and Fleas	Ticks and Lice	Total
Kano Municipal Council	42	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Nassarawa	48	3(6.3)	2(4.2)	1(2.1)	6(12.5)
Tarauni	52	2(3.8)	1(1.9)	1(1.9)	4(7.7)
Gwale	49	7(14.3)	3(6.1)	5(10.2)	15(30.6)
Dala	53	0(0.0)	2(3.8)	0(0.0)	2(3.8)
Fagge	48	0(0.0)	1(2.1)	2(4.2)	3(6.3)
Kumbotso	52	1(1.9)	3(5.8)	1(1.9)	5(9.6)
Ungoggo	56	3(5.4)	1(1.8)	2(3.6)	6(10.7)
Total	400	16(4.0)	13(3.3)	12(3.0)	41(10.3)

Discussion

The present study provides critical insights into the public health significance of domestic rats (*Rattus rattus*) as vectors of zoonotic parasites within Kano State metropolis. The study determined the distribution of ectoparasites among captured rats, and elucidates their zoonotic implications towards the spread of parasitic diseases, thereby exploring the potential pathways of parasite transmission. Therefore, our findings provide the first baseline information on the prevalence of ectoparasites among domestic rats (*Rattus rattus*) in Kano State, Nigeria.

The overall ectoparasites prevalence of sampled rats reported in this study (67.8%) was higher than that reported by Sumangali *et al*. (2012) (66.7%), Sayed *et al*. (2024) (51.3%) and Gholipoury *et al*. (2016) (38.5%); and lower than that detected by Stojčević *et al*. (2004) (72.6%) and Shija et al. (2025) (71.5%). This might be explained by the difference in geographical situations, climates and seasons (Archer *et al*., 2017).

The preponderance of ticks and fleas in domestic rats was documented previously by Larena and Mougeot (2022). The presence of fleas in this study agrees with the findings of Ogunniyi et al. (2014), Harrison et al. (2015), Kusumarini et al. (2021), Rehman et al. (2022) and Sayed et al. (2024) where fleas were predominant among the ectoparasites. However, the results did not agree with the studies of Asiry and Fetoh (2014), Hamidi et al. (2015), Moravvej et al. (2015), Premaalatha et al. (2017) and Sharma et al. (2018) where fleas represent the lowest prevalence among the other ectoparasites (tick, mite, and lice). Both the two species were marked vector of

zoonotic parasites according to researches. For example, the bite of an infected tick and fleas was reported among the ways through which human gets infected with *Babesia* (Homer et al., 2000) and bubonic plague (Mustapha et al., 2019) respectively. A tick species, in particular Haemaphysalis spp has been reported to be a prominent transmitter of the protozoan Babesia spp, a causative agent of babesiosis, Theileria spp, Anaplasma spp, Rickettsia spp, and Bartonella spp (Walker et al. 2003). Additionally, Kusumarini et al. (2021) reported that many species of fleas especially *Xenopsylla cheopis* are biological vector of trypanosomes. Thus, reflecting a great possibility of cross transmission of *Babesia spp*. and *Trypanosoma spp*. from rat to the inhabitants of the study area. This is undoubtedly in consonant with the views of Mustapha et al., (2019) Abdullahi and Tijjani (2020) and Jamil et al., (2022). Additionally, rat fleas can transmit diseases such as *Yersinia pestis*, *Salmonellosis*, *Tularemia*, and *Bartonella*, as confirmed by studies conducted by Tay et al. (2014), and Farid et al. (2021).

The prevalence of mites in this study was in line with earlier reports by Ogunniyi et al., (2014), Mustapha et al., (2019) and Abdullahi and Tijjani (2020) and Kusumarini et al., (2021); who reported a similar prevalence of mite among different species of rodents. While the prevalence of lice in rats supports the findings of Shahi and Pakari (2007), Yang et al. (2009) and Frye et al. (2015). However, the lower prevalence of bugs encountered in the present study contradicts that reported in previous studies. This discrepancy could be related to the climate unfavourable to bug development during the study period. These arthropod insects were documented as vehicle of disease transmission to man and domestic animals. For example, some species of mites causes dermatitis in humans and facilitate the transmission of filariasis. Lice particularly *Polyplax spp*., can contribute in the transmission of *T. lewisi* and *Hemobartonella muris*, while the infestation was medically associated with transmission of plague bacilli and tularemia bartonellosis in man and rodents. The bite however, causes a condition called pediculosis in human (Mustapha et al., 2019).

Conclusion

The study showed that domestic rats captured within the metropolitan areas of Kano are infested with various ectoparasites such as lice, ticks, mites, bugs and fleas; which might serve as vehicle for zoonotic transmission of parasites to the inhabitant of the study area. However, the findings of this study will enrich the literature and can be used as a baseline for future research on ectoparasites in domestic rats. Therefore, the present study underscores the need for the use of rodenticides and increase awareness among the local community about the exposure to rats and rodent-borne diseases. Further molecular and immunological investigations are also encouraged for better understanding of cross-transmission of zoonotic pathogens and development of effective control strategies.

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Authors' Contribution

This work was carried out in collaboration between all authors. HHH and YA were involved in the research design. Author HHH carried out the laboratory work and analysis of result. Authors YA, AJ, KMA and GNY were involved in contribution of resources, field capture of the animals, supervision and co-editing the manuscript. All authors read and approved the final manuscript.

Competing Interest

The authors declare that there is no competing interest on the manuscript.

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