Asian Journal of Research in Animal and Veterinary Sciences

Volume 7, Issue 3, Page 256-265, 2024; Article no.AJRAVS.120281

Prevalence of Parasite and Occurrence of Co-Infection in Pigs Reared in Extensive Farms in Gombe State, Nigeria

Akwaras, M. [a], James-Rugu, N. N. [a], Ololade, A.D. [b*] and Otakpa, E.O. [a]

[a] University of Jos, Nigeria.
[b] University of Abuja, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Authors AM and OEO collected study samples. Author AM performed laboratory and statistical analysis. Author JRNN designed the study and methodology. Author OAD wrote the first and final draft. Authors JRNN and OAD validated the statistical analysis and the identification of parasites. All authors read and approved the final manuscript.

Article Information

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/120281

Original Research Article

Received: 20/05/2024
Accepted: 23/07/2024
Published: 06/08/2024

ABSTRACT

Aims: The study aimed to determine the prevalence and occurrence of parasites of pigs reared in extensive farms in Billiri and Kaltungo Local Government Areas of Gombe State, Nigeria.
Study Design: Quantitative Study Design.
Place and Duration of Study: Samples were collected in Billiri and Kaltungo Local Government Areas of Gombe State, Nigeria.

**Corresponding author: E-mail: ololafemi@yahoo.com;*

Cite as: *M., Akwaras, James-Rugu, N. N., Ololade, A.D., and Otakpa, E.O. 2024. "Prevalence of Parasite and Occurrence of Co-Infection in Pigs Reared in Extensive Farms in Gombe State, Nigeria". Asian Journal of Research in Animal and Veterinary Sciences 7 (3):256-65. https://www.journalajravs.com/index.php/AJRAVS/article/view/310.*

Methodology: The laboratory analyzed six hundred fresh faecal samples collected from the rectum of pigs within two Local Government areas through floatation and sedimentation techniques. The data obtained was analyzed using chi-square goodness of fit to determine if there was a significant association between infection in the pigs and the various parameters studied at a 5% level of significance.

Results: This study identified sixteen parasites: protozoan, Platyhelminthes and nematodes, and coccidia. The prevalence of parasites in the study area is 83.0%, Billiri had 252 (84.0%) infected pigs out of 300 samples collected and Kaltungo had 246 (82.0%) infected pigs out of the 300 samples collected. The difference in the prevalence between the two study locations is not statistically significant (p> 0.05). In relation to the age and sex of pigs sampled from Billiri Local Government Area, adult males had a higher infection rate (94.7%) compared to the females (84.6%), also, the young males had a higher infection rate (84.4%) compared to young females (76.7%). On the other hand, the results obtained from Kaltungo showed that adult females had a higher infection rate (78.3%) compared to adult males (75.0%) while young males had a higher prevalence (84.3%) compared to young females (83.3%). However, the variations are not statistically significant (p> 0.05). Also, there is a significant difference between single and mixed infections across the study areas.

Conclusion: There was no significant difference in the prevalence of parasites based on the location, age, and sex of pigs. However, there is significant difference in the occurrence of single and co-infection across the two study locations; single infection was significantly higher in Kaltungo while co-infection infections were significantly higher in Billiri. This indicates the need for effective parasite control measures, including prophylactic and therapeutic anthelmintic programmes. This will enhance the productivity of pigs in the study locations and ensure the availability of safe pork for public consumption.

Keywords: Parasite; parasite coinfection; Nigeria; prevalence; mixed infection; pigs.

1. INTRODUCTION

The pig industry in Nigeria has witnessed tremendous growth both in consumption and production [1]. According to FAO (2019), the estimated population of pigs in Nigeria has risen from 3.5 million in the 1990s to about 7.5 million [2]. This development means an increase in animal protein for human consumption, employment opportunities, reduction in poverty and an increase in the nation's GDP [3]. The performance of animal production in itself is related to the animal production system [4], animal genetics [5], and the location of production [6]. The rearing systems in pig production range from the traditional extensive (mostly practised in rural areas) to the modern intensive (urban) rearing systems. In Nigeria, the pig-rearing system is mostly practised extensively as a family business [7]. It is also seen as a form of cash reserve for solving immediate financial problems [8]. However, pig farming has been practised traditionally in the villages as backyard farming with 1-50 pigs and in semi-urban areas on large-scale farms [9,10].

Parasites are a major limiting factor in livestock production [1], and the scavenging feeding habit in pigs subjects them to parasites by picking eggs [11]. The devastating effects of such parasites include high mortality, reduced feed conversion, and reduction in reproductive performance [12]. This extensive rearing of pigs as domesticated animals makes infected pigs a major cause of zoonosis [1]. Parasites such as Ascaris, Cryptosporidium, Giardia, Taenia species have been reported as major swine zoonosis [13].

The parasitic co-infection occurrence has been widely published in several hosts especially of potential zoonotic diseases, which could be a major public health challenge. The term Co-infection or mixed infection is commonly used to describe the associated infection of parasites in a host by separate pathogens: Infection by more than one type of parasite [14]. Also, there is limited information regarding the prevalence of gastrointestinal parasites and their public health significance across Billiri and Kaltungo Local Government Areas of Gombe State. This knowledge will help in developing extension programs for local farmers, it will also help the relevant authorities to understand the possible health risks associated with and develop prophylactic measures to reduce the parasite transmission among herds thereby boosting pork production and limiting economic loss.

Additionally, the knowledge of this research will also help create awareness of the public health hazards of extensive pig rearing to humans and other livestock.

2. MATERIALS AND METHODS

2.1 Study Area

Gombe State occupies part of the central position of the Northeastern part of Nigeria and has eleven Local Government Areas. Billiri and Kaltungo Local Government Areas are located in the Southern part of the state. Billiri is located between latitude 9° 31′ and 10° 02′ North of the Equator, and Longitude 10° 57′ and 11° 24′ East of Greenwich Meridian, and Kaltungo Local Government Area to the North- East and Eastern parts respectively (Adamu et al., 2013). The area experiences an average rainfall of about 1,600mm. Billiri LGA lies between 50m and 700m above mean sea level (Butu et al., 2020). Billiri Local Government has an average population of 202,000 (NPC, 2006). Kaltungo LGA in Gombe state is located between latitudes 9^0 48' 00N to 9^0 50' 38N and longitudes 11^0 16' 00E to 11^0 19' 45'E. The area has a mean maximum temperature of 31^0c and an average annual rainfall of 1550 7mm (Carter et al., 1963). The topography of the area rises from 402 meters to 702 meters above mean sea level. The population of the area is about 160,000 [15], and the people are predominately farmers, and also rear animals.

2.1.1 Collection of faecal samples

A total of six hundred (600) samples were collected from the two local government areas, three hundred (300) from each local government, Samples were collected from households that rear pigs and are willing to participate in the study within the selected sampling locations.

A fresh faecal sample was collected directly from the rectum using disposable hand gloves. The sample was placed in a sample bottle which was appropriately labelled with the age, sex, and location of collection. It was preserved in an ice box and transported to the Parasitology Division, National Veterinary Research Institute (NVRI), Vom for laboratory analysis. Samples that were not analyzed on the same day were stored at -20^{oC}.

2.1.2 Laboratory procedure

The faecal samples collected were analyzed in the laboratory using the concentration-floatation and sedimentation technique [16].

Floatation method: Ten (10ml) mils of saturated salt solution (SSS) were dispensed into a wide-mouth universal container.1g of faecal sample was added and emulsified using an applicator stick. The mixture was sieved into another container and filled to the brim with SSS. A clean, grease-free glass slide was used to cover it, ensuring that the mixture was in contact with the glass slide. This was allowed to stand undisturbed for about 10 to 15 minutes. The glass slide was then removed, inverted and viewed under the microscope using ×10 objective lens and confirmed with ×40 objective lens.

Sedimentation method: Ten (10mls) mils of SSS were dispensed into a wide-mouth universal container. 1g of faecal sample was added and emulsified using the applicator stick. The mixture was sieved into another container and filled to the brim with SSS. It was allowed to stand undisturbed for about 10 to 15 minutes. The supernatant was discarded and the deposit was viewed under the microscope using ×10 objective lens and confirmed with ×40 objective lens.

2.1.3 Identification of parasites

Parasites obtained were identified using identification keys based on their morphological features [17] and [18] under the microscope. All the gastrointestinal parasites identified were recorded in information charts.

2.1.4 Statistical analysis

Data obtained was analyzed using the $\chi 2$ goodness of fit test and the $\chi 2$ test of association to determine if there was a significant association between infection in the pigs and the various parameters studied at a 5% level of significance.

3. RESULTS AND DISCUSSION

Out of the 600 samples, 498 (83.0%) were found to be infested with one or more intestinal parasites. Billiri Local Government Area had an infestation rate of 84.0% while Kaltungo Local Government Area had an infestation rate of

82.0% as noted in Table 1 although the difference between the two Local Government Areas was not statistically significant (p>0.05).

Table 2 shows the prevalence of gastrointestinal parasites across Billiri and Kaltungo in relation to the age and gender of the pigs sampled. Generally, infection was higher in adult pigs sampled from Billiri, 80 (88.9%) with the least infection recorded in adult pigs sampled from Kaltungo, 60 (76.9%). A total of 90 adult pigs were examined in Billiri. More males, 36(94.7%) were infected than females, 44(84.6%). Similarly, of the 210 young pigs examined in Billiri for gastrointestinal parasites, the infection rate was higher in the male pigs, 78(84.4%) compared to

Table 1. Gastrointestinal Parasites Encountered in Pigs Sampled from Billiri and Kaltungo Local Government Areas of Gombe State

Location	Number examined	Number Infected	(%) infected	*P-value*
Billiri	300	252	84.0	0.58
Kaltungo	300	246	82.0	
Total	**600**	**498**	**83.0**	

Table 2. Gastrointestinal Parasites Encountered in Relation to Age and Gender of Pigs sampled from Billiri and Kaltungo Local Government Areas

Location	Age	Sex	No. Examined	No. Infected (%)	*P*-value
Billiri	Adult	Male	38	36 (94.7)	
		Female	52	44 (84.6)	0.181
		Total	90	80 (88.9)	
	Young	Male	92	78 (84.4)	
		Female	118	94 (76.7)	0.371
		Total	210	172 (81.9)	
Kaltungo	Adult	Male	32	24 (75.0)	
		Female	46	36 (78.3)	0.789
		Total	78	60 (76.9)	
	Young	Male	102	86 (84.3)	
		Females	120	100 (83.3)	0.857
		Total	222	186 (83.3)	

Table 3. Species of Gastrointestinal Parasites Encountered in Pigs Sampled from Billiri and Kaltungo Local Government Area

Phylum	Parasite encountered	Billiri	Kaltungo
		No. encountered (%)	**No. encountered (%)**
Protozoa	*Coccidia oocyst*	188 (45.40)	200 (56.20)
Nematoda	*Ascaris suum*	8 (1.90)	12 (3.40)
	Ascarops strongylina	30 (7.20)	48 (13.50)
	Globocephalus connorfilli	16 (3.90)	
	Hyostrongylus rubidus	14 (3.40)	
	Metastrongylus spp.	4 (1.00)	
	Necator spp.	8 (1.90)	
	Oesophagostomum dentatum	58 (14.00)	68 (19.10)
	Physocephalus sexalatus	50 (12.10)	6 (1.70)
	Stephanurus dentatus	20 (4.80)	8 (2.20)
	Strongyloid spp.	2 (0.50)	6 (1.70)
	Capilaria spp.	2 (0.50)	
	Dicrocoelium spp.	12 (2.90)	4 (1.10)
	Diphyllobothrium latum		2 (0.60)
Platyhelminthes	*Monezia* spp.		2 (0.60)
	Paragonimus westermani	2 (0.50)	
	Total	**414 (53.8)**	**356 (46.20)**

the females, 94(79.7%). However, in both age groups examined, there was no significant association between gastrointestinal infection and the sex of the pigs examined (*P*=0.05). On the other hand, in Kaltungo, out of the 78 adult pigs examined, females harboured more of the infection 36 (78.3%) than the male pigs 24 (75.0%), while in the young pigs examined, males harboured more of the infection, 86 (84.3%) as compared to the females, 100 (83.3%). But again, it was observed that infection was not associated with the sex of the pigs in both age groups based on the χ2 test (*P*=0.05).

The findings of this study revealed the presence of 16 gastrointestinal parasites (Table 3). The protozoan parasite Coccidia oocyst had the highest infection rates of 45.40% and 56.20% in Billiri and Kaltungo respectively. In Billiri, the nematode parasites identified were Oesophagustomum dentatum (14.00%), Physocephalus sexalatus (12.10%), Ascarops strongylina (7.20%), Stephanurus dentatus (4.80%), Globucephalus carnofili (3.90%), Hyostrongylus rubidus (3.40%), Dicrocoelium species (2.90%), Ascaris suum (1.90%), Necartor species (1.90%), Metastrongylus species (1.00%), Strongyloid species (0.50%) and Capilaria species (0.50%) while Paragonimus westermani (0.50%) was the only platyhelminth parasite encountered. On the other hand, Oesophagustomum dentatum (19.10%), Ascarops strongylina (13.50%), Ascaris suum (3.40%), Stephanurus dentatus (2.20%), Strongyloid species (1.70%), Physocephalus sexalatus (1.70%), Dicrocoelium species (1.10%) were the nematode parasites identified in Kaltungo while Moniezia species (0.60%), and Diphylloborthrium species (0.60%) were the platyhelminths identified.

The occurrence of single and mixed infections is outlined in Tables 4 and 5 respectively. Single parasite infection was significantly higher (*P*=0.05) in Kaltungo 152(55.10%). Generally, Coccidia oocyst appeared to be the most prevalent 192(69.60%) parasite when both locations were considered altogether. On the other hand, multiple infection was significantly higher (*P*=0.05) in Biliri 130(58.560%) with infection from Coccidia oocyst + Oesophagostomum dentatum, 54(24.30%) observed to be highest across both locations (Table 5).

Table 4. Occurrence of Single infections of Gastrointestinal Parasites of pigs sampled from Billiri and Kaltungo Local Government Areas

Parasites Identified	Billiri	Kaltungo	Total (%)
	Frequency (%)	Frequency (%)	
Ascaris suum		6 (100.00)	6 (2.20)
Ascarops strongylina	12 (54.50)	10 (45.50)	22 (8.00)
Coccidia oocyst	76 (39.60)	116 (60.40)	192 (69.60)
Dicrocoelium	2 (50.0)	2 (50.00)	4 (1.40)
Globocephalus cannorfilli	4 (100.0)		4 (1.40)
Hyostrongylus rubidus	4 (100.0)		4 (1.40)
Oesophagostomum dentatum	12 (46.20)	14 (53.80)	26 (9.40)
Physocephalus sexalatus	14 (87.50)	2 (12.50)	16 (5.80)
Stephanurus dentatus		2 (100.00)	2 (0.70)
Total	124 (44.90)	152 (55.10)	276 (100.00)

χ^2 =31.149, df=8, P=0.000 Prevalence of parasite:

Table 5. Occurrence of Co-infection of gastrointestinal parasites in pigs sampled from Billiri and Kaltungo Local Government Area

Parasites encountered	Biliri	Kaltungo	Total (%)
	Frequency (%)	Frequency (%)	
Ascarops strongylina + Oesophagostomum dentatum	2 (25.0)	6 (75.0)	8 (3.60)
Ascarops strongylina + Coccidia oocyst	4 (16.7)	20 (83.3)	24 (10.80)
Ascarops strongylina + Coccidia oocyst + Oesophagostomum dentatum	4 (40.0)	6 (60.0)	10 (4.50)
Ascarops strongylina + Coccidia oocyst + Stephanurus dentatus	2 (100.0)	0 (0.0)	2 (0.90)

Parasites encountered	Biliri	Kaltungo	Total (%)
	Frequency (%)	Frequency (%)	
Ascarops strongylina + *Physocephalus sexalatus* + *Globocephalus connorfilli* + *Necator* spp.	2 (100.0)	0 (0.0)	2 (0.90
Coccidia oocyst + *Ascaris suum*	6 (50.0)	6 (50.0)	12 (5.40)
Coccidia oocyst + *Ascaris suum* + *Oesophagostomum dentatum*	2 (33.3)	4 (66.7)	6 (2.70)
Coccidia oocyst + *Dicrocoelium*	10 (83.3)	2 (16.7)	12 (5.40)
Coccidia oocyst + *Diphylobothrium latum*	0 (0.0)	2 (100.0)	2 (0.90)
Coccidia oocyst + *Globocephalus cannorfilli*	10 (100.0)	0 (0.0)	10 (4.50)
Coccidia oocyst + *Globocephalus connorfilli* + *Physocephalus sexalatus* + *Ascarops strongylina*	2 (100.0)	0 (0.0)	2 (0.90)
Coccidia oocyst + *Hyostrongylus rubidus*	4 (100.0)	0 (0.0)	4 (1.80)
Coccidia oocyst + *Monezia* spp. + *Strongyloid* spp.	0 (0.0)	2 (100.0)	2 (0.90)
Coccidia oocyst + *Necator* spp. + *Oesophagostomum dentatum*	2 (100.0)	0 (0.0)	2 (0.90)
Coccidia oocyst + *Oesophagostomum dentatum*	24 (44.4)	30 (55.6)	54 (24.30)
Coccidia oocyst + *Oesophagostomum dentatum* + *Ascarops strongylina* + *Capilaria*	2 (100.0)	0 (0.0)	2 (0.90)
Coccidia oocyst + *Oesophagostomum dentatum* + *Stephanurus dentatus*	0 (0.0)	2 (100.0)	2 (0.90)
Coccidia oocyst + *Physocephalus sexalatus*	18 (100.0)	0 (0.0)	18 (8.10)
Coccidia oocyst + *Physocephalus sexalatus* + *Oesophagostomum dentatum* + *Ascaris suum*	2 (100.0)	0 (0.0)	2 (0.90)
Coccidia oocyst + *Physocephalus sexalatus* + *Stephanurus dentatus*	10 (100.0)	0 (0.0)	10 (4.50)
Coccidia oocyst + *Stephanurus dentatus*	8 (80.0)	2 (20.0)	10 (4.50)
Coccidia oocyst + *Stephanurus dentatus* + *Ascarops strongylina*	0 (0.0)	2 (100.0)	2 (0.90)
Coccidia oocyst + *Strongyloid* spp.	0 (0.0)	2 (100.0)	2 (0.90)
Necator spp. + *Paragonimus westermani* + *Physocephalus sexalatus*	2 (100.0)	0 (0.0)	2 (0.90)
Oesophagostomum dentatum + *Hyostrongylus rubidus* + *Stephanurus dentatus*	4 (100.0)	0 (0.0)	4 (1.80)
Oesophagostomum dentatum + *Metastrongylus*	2 (100.0)	0 (0.0)	2 (0.90)
Oesophagostomum dentatum + *Physocephalus sexalatus* + *Coccidia oocyst*	2 (50.0)	2 (50.0)	4 (1.80)
Oesophagostomum dentatum + *Stephanurus dentatus*	0 (0.0)	2 (100.0)	2 (0.90)
Physocephalus sexalatus + *Metastrongylus*	2 (100.0)	0 (0.0)	2 (0.90)
Strongyloid spp. + *Necator* spp + *Hyostrongylus rubidus* + *Coccidia oocyst*	2 (100.0)	0 (0.0)	2 (0.90)
Strongyloid spp. + *Physocephalus sexalatus* + *Ascaris suum*	2 (50.0)	2 (50.0)	4 (1.80)
Total	130 (58.6)	92 (41.4)	222 (100.0)

χ^2 =97.691, df=30, P=0.000

3.1 Discussion

The general assessment of gastrointestinal parasites in Billiri and Kaltungo Local Government Areas was found to be 84.0% and 82.0% respectively with an overall prevalence of 83.0%.

The prevalence obtained in Billiri is higher than what was obtained by Lekko et al. [19] in the same study location. This showed that there has been an increase in the rate of infection within the period of the two studies. This can be attributed to poor farming and management practices, defective control measures or the development of anthelmintic resistance by the parasites within the study area.

The overall prevalence obtained in this study is higher than what was stated by Karaye et al. [20]

in some parts of Nassarawa State, it is also higher than what was revealed by Shitta et al. [21] in Mayo-Belwa Adamawa State and what was obtained by Amuta et al. [22] in Makurdi, Benue State. However, it is lower than what was pointed out by Chibuzor et al. [1] in Jema'a Local Government Area, Kaduna State and what was observed by Adhikari et al. [23] in South Central Nepal. The difference in the overall prevalence may be attributed to the difference in geographical locations, poor animal husbandry practices such as stocking rate, the nature of their diet and the immunity status of the pigs [24]. The feeding habit of the pigs is also a contributing factor to the high level of infection, Pigs are known to be omnivorous with voracious feeding habits which predisposes them to parasitic infections [21,25]. Similarly, the poor management system practised in the study areas was evident in the porous and unhygienic shelter provided for the pigs as most of them were tied under trees with their faecal material accumulating within the area and food was also served within the same area in unkept bowls or directly on the ground. The high prevalence rate may also be indicative of the limited veterinary care for pigs in the study areas.

Generally, infection with gastrointestinal parasites in relation to age showed that the adults had a higher infection rate than the young in Billiri while the young had a higher infection rate in Kaltungo. The high infection rate in adults is in accordance with the study conducted by Amadi et al. [26] in Umuahia, Dey et al. [27] in Bangladesh and Lekko et al. [19] in Billiri. The finding can be attributed to the longer stay of the adults in the herd which predisposes them to more parasites over time. In Kaltungo however, the high infection rate in younger animals is in agreement with the findings of Sowemimo et al. [28]. The high prevalence in young can be due to the lack of immunity developed from pre-exposure to parasites.

The result obtained showed that both adult and young males had higher infection rates than adult and young females sampled from Billiri Local Government Area, whereas in Kaltungo Local Government Area, adult females had higher infection rates compared to adult males. On the other hand, the young males had a higher infection rate than the young females. However, there was no significant difference in these infection rates in both Billiri and Kaltungo Local Government Areas. This showed that both males and females have equal chances of being infected with intestinal parasites when exposed.

The Parasites encountered in this study cut across the phyla Protozoa, Platyhelminthes, and Nemoda. For Protozoa, the only parasite identified was Coccidia oocyst which had the highest prevalence in Billiri and Kaltungo. The Platyhelminthes were Diphylobothrium latum, Monezia species all in Kaltungo and Paragonimus westermani in Billiri Local Government Area. Furthermore, the Nematodes identified include Oesophagustomum dentatum, Ascarops strongylina, Ascaris suum, Dicrocoelium species, Strongyloid species, Physocephalus sexalatus, Stephanurus dentatus in Billiri and Kaltungo. However, Globocephalus cannofilli, Necator species, Hyostrongylus rubidus, Metastrongylus species, and Capilaria species were identified in Billiri but absent in Kaltungo. The identification of Coccidia oocyst, Paragonimus westermani, Strongyloid species, Oesophagustomum dentatum, and Ascaris suum were synonymous with the findings of Lekko et al. [19] in a similar study in Billiri. Similarly, Ascaris suum, Oesophagustomum dentatum, Strongyloid species, as well as Coccidia oocyst were identified by Pam et al. [28], Akanni et al. [29], and Amadi et al. [26] in Langtang North Local Government Area Plateau State, Jos South Local Government Area Plateau State and Umuahia North Local Government in Abia State respectively. The high prevalence of Coccidia oocyst in this study is in contrast with the result obtained by Shitta et al. [21] in Mayo-Belwa, Adamawa State where Ascaris suum was most prevalent followed by Coccidia oocyst. This may be attributed to the unhygienic environment in which the pigs are feed. Coccidia oocyst is transmitted through the faecal-oral route, therefore transmission is favoured when the faeces of the pigs are allowed in the same environment they feed for a long time [30].

The occurrence of single infections was higher in Kaltungo Local Government Area while the occurrence of mixed infections was higher in Billiri Local Government Area. Both single and mixed infections were found to be significantly ($p<0.05$) associated with location as more single infection cases were observed in Kaltungo while multiple infections were observed to be higher in Billiri. This is in agreement with the findings of Chibuzor, et al. [1] who recorded single and mixed infections with intestinal parasites in Pigs in Chikun and Jema'a local government areas in

Kaduna State. Also, coinfection was recorded in Pigs at Nsukka, Southeast Nigeria [25].

The findings in the study showed high parasite prevalence and posed a public health concern, however, the occurring co-infection observed in the study may make it more difficult to eradicate parasites and increase the likelihood of epidemiological outbreaks within and outside the study environment.

4. CONCLUSION

The results of this study have given fundamental information about the abundance, distribution and types of intestinal parasites of pigs in the study area. It indicates the presence of 14 parasites in Billiri and 10 parasites in Kaltungo, with Coccidia oocysts having the highest prevalence in both study locations. The overall prevalence of parasites stands at 83.0% while prevalence from Billiri and Kaltungo were 84.0% and 82.0% respectively. There was no significant difference in the prevalence of intestinal parasites based on location, age and sex of pigs. However, there is a significant difference in the occurrence of single and mixed infections across the two study locations; single infection was significantly higher in Kaltungo while mixed infections were significantly higher in Billiri. This indicates the need for effective parasite control measures, including prophylactic and therapeutic anthelmintic programmes. This will enhance the productivity of pigs in the study locations and ensure the availability of safe pork for public consumption. Further research should be carried out within Gombe State to ascertain the parasite relationship within is environment.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large used during the writing or editing of manuscripts.

CONSENT AND ETHICAL APPROVAL

Ethical clearance was obtained from the Ministry of Agriculture, Animal Husbandry and Cooperatives in Gombe, Gombe State with Ref: MAAH&CO/VLS/S/DIS/330. The Community heads of the various villages marked for sample collection were visited prior to the sampling days. This was done in order to seek for their blessings and assistance in sensitizing their wards on the importance of the research. The consent of farmers was also sought before involving them in the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chibuzor IN, Benjamin O, Umar Y, Karderam BD. Study of intestinal helminths of swine from Chikun and Jema'a local government areas of Kaduna state, Nigeria. FUDM Journal of Science. 2021;5(3):72-75
2. Butu AW, Bilal GN, Emeribe CN, Bichi AA. Physicochemical and microbial parameters in domesticated water source in Billri Local Government Area, Gombe State, Nigeria. Journal of Forestry, Environment and Sustainable Development. 2020;6(1):123-141.
3. Cheesbrough M. District LABORATORY practice in tropical countries, part 2 published by the press sundicate of the University of Cambridge, U.K. 2000;320-321.
4. Unigwe R, Egwu L, Ukwueze C. Prevalence of gastro-intestinal helminths of slaughtered pigs at Bodija abattoir, Ibadan, Oyo State, Nigeria. Bio-Research. 2022;20:1506-1512.
DOI: 10.4314/br.v20i2.1
5. Kanis E, Greef KHD, Hiemstra A, Arendonk JAMV. Breeding for societally important traits in pigs. Journal of Animal Science. 2008;83:948-957.
6. Iyai DA, Randa SY. Characteristics of the three Pig keeping systems on performance of small-scale Pig Farmers at Manokwari, West Papua. Journal of Peternakan Indonesia. 2011;13(2):83-91.
7. Onunkwo JI, Njoga EO, Nwanta JA, Shoyinka SVO, Onyenwe IW, Eze JI. Serological survey of porcine brucella infection in Southeast, Nigeria. Nigerian Veterinary Journal. 2011;(32):60–62.
8. Ekere SO, Njoga EO, Onunkwo JI, Njoga UJ. Serosurveillance of brucella antibody in food animals and role of slaughterhouse workers in the spread of Brucella infection in Southeast Nigeria. Veterinary World. 2018;(11):1171–1178.
9. Ajala MK, Adesehinwa AOK, Mohammed AK. Characteristics of smallholder pig production in southern Kaduna area, Kaduna State, Nigeria. American-Eurasian Journal of Agriculture and Environmental Science. 2007;2:182-187.

10. Abiola JO, Omotosho OO, Adeniyi OM, Ayoade GO. Socio-demographic characteristics of swine producers and swine management practice in Ibadan, Oyo state Nigeria. Alexandria Journal of Veterinary Sciences. 2015;47(1):18-23.
11. Uchechi NC, Udegbunam C. Rural pig production and pork consumption in Imo State, Nigeria. Nigerian Journal of Animal Science. 2023;22(1):165–185. Available:https://www.njas.org.ng/index.php/php/article/view/788
12. Nissen S, Paulson I, Nejsum P, Olsen A, Roepstorff A, Rubaire A, Thamsborg SM. Prevalence of gastrointestinal nematodes in growing pigs in Kabale District, Uganda. Tropical Animal Health and Production. 2011;43(3):567-572.
13. Ololade AD, Olanrewaju CA, Malann YD. Risk factors and prevalence of porcine Cysticercosis and Epilepsy Survey among Humans in Ibadan, Oyo State. Nigerian Journal of Parasitology. 2022;43(1): 85-92.
14. Saade G, Deblanc C, Bougon J. et al. Coinfections and their molecular consequences in the porcine respiratory tract. Vet Res. 2020;51:80. Available:https://doi.org/10.1186/s13567-020-00807-8
15. National Population Commission (NPC). Population of the federal republic of Nigeria Gombe State Statistical table; 2006. Retrieved from www.citypopulation.de
16. Soulsby EJL, Helminths, arthropods, and protozoa of domestic animals. 7th edition, Clows, London; 1982.
17. FAO. Animal health manual: Epidemiology, diagnosis and control of helminth parasites of swine. Danish Centre for Experimental Parasitology. The Royal Veterinary and Agricultural University, Copenhagen, Denmark; 1998.
18. Maxime D, Pol F, Dufour B, Rose N. Pig farming in alternative systems: Strengths and challenges in terms of animal welfare, biosecurity, animal health and pork safety. Agriculture. 2020;10(7):261, Available:http://doi.org/10.3390/agriculture10070261
19. Lekko MY, Lawal RJ, Dauda J, Waziri DI. Occurrence and public health implications of gastrointestinal parasites of domesticated pigs (*Suis scrofa* domesticus) in Billiri local government area, Gombe state, Nigeria. Science Journal of Veterinary Advances. 2017;6(9):187-194.
20. Karaye GP, Iliyasu D, Dogo AG, Madu HK. Prevalence of swine gastrointestinal parasites in four selected local government areas of Nasarawa State, Nigeria. International Journal of Livestock Research. 2016;6(1):21-26.
21. Shitta KB, James-Rugu NN, Halima A, Sara AA, Chessed G. Most common intestinal parasites affecting swine production in extensive farms in mayo-belwa Adamawa State, North-Eastern Nigeria. Bayero Journal of Pure and Applied Sciences. 2019;12(1):725-729.
22. Amuta EU, Houmsou RS, Amuta PO, Ochokwunu O. Gastrointestinal parasites of swine under small scale management in Makurdi, Benue State, Nigeria. Nigerian Journal of Parasitology. 2015;36(1):67-71.
23. Adhikari RB, Adhikari DM, Thapa s, Ghimire TR. Gastrointestinal parasites of indigenous pigs (*Sus domesticus*) in South-Central Nepal. Veterinary Medicine and Science. 2021;7(5):820-830. DOI: 10.1002/vms3.536
24. Hlongwane NL, Hadebe K, Soma P, Dzomba EF, Muchadeyi FC. Genome-wide assessment of genetic variation and population distinctiveness of the pig family in South Africa. Frontiers in Genetics. 2020;7;11:344. Available:https://doi.org/10.3389/fgene.2020.00344
25. Abonyi OF, Njoga OE. Prevalence and determinants of gastrointestinal parasite infection in intensively managed pigs in Nsukka Agricultural Zone, Southeast Nigeria. Journal of Parasitic Diseases. 2020;44(1):31-39. Available:https://doi.org/10.1007/s12639-019-01158-8
26. Amadi AN, Ubiaru PC, Ugagu GM, Ibediiugha BN, Obeagu IA, Njikenonye A. Preliminary study on the prevalence of gastrointestinal parasites of pigs managed and slaughtered in umuahiath LGA of Abia State, Nigeria. Animal Research International. 2018;15(2):3013-3019.
27. Dey TR, Dey AR, Begum N, Akther S, Barmon BC. Prevalence of endo parasite of pigs at Mymensingh, Bangladesh. Journal of Agricultural and Veterinary Science. 2014;7(4):31-38.
28. Pam VA, Ogbu KI, Bata SI, Obalisa A, Akut K, Hassan AA. An investigation of

haemo and gastrointestinal parasites of pigs in some parts of Langtang North local government area of Plateau state. IOSR Journal of Engineering. 2013;3:10-14.

29. Ngwili N, Thomas L, Githigia S, Muloi D, Marshall K, Wahome R, Roesel K. Co-infection of pigs with *Taenia solium* cysticercosis and gastrointestinal parasites in Eastern and Western Uganda. Parasitology Research. 2022 Jan;121:177-89. Available:https://link.springer.com/article/10.1007/s00436-021-07380-9

30. Oba P, Wieland B, Mwiine FN, Erume J, Dione MM. Co-infections of respiratory pathogens and gastrointestinal parasites in smallholder pig production systems in Uganda. Parasitology research. 2023 Apr;122(4): 953-62. Available:https://link.springer.com/article/10.1007/s00436-023-07797-4

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/120281