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PREVALENCE OF HELMINTH PARASITES OF SWINE IN THREE SELECTED LOCAL GOVERNMENT AREAS OF IBADAN, OYO STATE, NIGERIA

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ABSTRACT: *Background: Helminth infections of swine are common, but reports on the economic losses are not available. Though they cause a reduction in weight gain by interfering with food digestion, absorption, and feed conversion efficiency, there has been an increase in feeding cost complicated by helminth parasite infections. The losses are difficult to substantiate due to the chronic nature of helminth infections. This study sought to determine the prevalence and associated risk factors of swine helminth infections in three local government areas of Ibadan, Oyo State, Nigeria. A simple random sampling technique was applied to selected pig farms and animals from three local government areas in Ibadan for participation. 10 grams of freshly voided faeces were collected from a total of 246 pigs into a sterile labelled bottle containing 10% formalin until processed. Faecal samples were examined in the Department of Veterinary Parasitology and Entomology Laboratory, Faculty of Veterinary Medicine, University of Ibadan. Oral interviews were made to assess the daily routine activities and health status of the pigs from farm owners. Results: The overall prevalence of helminth parasites of swine in this study was 34.2% while the species prevalence of four helminth parasites obtained in this study included: A. suum 35 (14.26%), T. suis 23 (9.3%), Oesophagostomum spp 17 (6.9%), and Strongyloides spp 9 (3.6%). Also, the overall single and mixed helminth infections were 70.2% and 29.8% in the three local government areas respectively; helminth parasitic load was highest in grower pigs (48.4%), followed by piglets (31.6%), and lowest in adult pigs (22.5%) without significant difference ($p>0.05$). Female pigs demonstrated a higher parasite burden (37.6%) than male pigs (30.6%) with no significant difference ($p>0.05$). Semi-intensively managed farms had a higher parasite load (71%) than those under the intensive system (24%) while farms that administered anthelmintic recorded a lower prevalence (15%), and those without had a higher (63%) significance ($p<0.05$). Pigs in Ona-Ara and Akinyele local government areas voided low ($EPG\leq100$) to moderate ($EPG\geq100<500$) amount of helminth eggs while pigs in Egbeda local government area excreted high ($EPG\geq500\leq1000$). Conclusion: The risk factors for helminth infections in pigs are age, sex, farm management practice, and anthelminthic administration.*

KEYWORDS: Prevalence, Swine, Helminth parasites, Farms, Dry season, Ibadan.

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INTRODUCTION

The human population in Nigeria has increased to around 200 million with its increasing demands for foods, especially animal proteins. "Porcine (Sus scrofa) is a tamed animal belonging to the animal family Suidae and the order Artiodactayla" (Adetunji & Adeyemo, 2011). Pigs are one of the most important domesticated animals in this country (Ugbomoiko et al., 2008), not only because farmers find them very easy to care for but also for their economic values (Osondu et al., 2014). Their population density has grown tremendously from 3.5 million in the 1990s to 7.5 million (FAO, 2019). The FMARD report in 2017 estimated that Nigeria's national herd accounts for 18.4 million cattle, 43.4 million sheep, 76 million goats, 7.1 million pigs, and 180 million poultry. A recent study has it that the per capita consumption of meat per year of a Nigerian is 9.2 kg, invariably making pig production a lucrative business and a source of employment generation (FAO, 2019). Production of pigs in Nigeria is most common in villages as backyard farming with 1–50 pigs and in semi-urban areas with large-scale farms (Ajala et al., 2007; Abiola et al., 2015).

Helminth parasitic infections are common in tropical and subtropical regions, especially where pigs are malnourished and open houses are regularly used (Eijck and Borgsteede 2005), with "overall low production performances and the infected organs may be condemned during postmortem inspection" (Kagira et al., 2012). "Losses often occur in domestic animals due to the chronic and subclinical nature of helminth infections compared to some acute or even fatal diseases" (Kumsa et al., 2010). Dey et al. (2014) and Nganga et al. (2008) compared the "effect of farm management systems on the rate of helminth infections and stated that pigs reared under the intensive system are less prone to parasitic infections than those raised traditionally without medical intervention or good hygiene practices due to close interactions with human beings, there are tendencies for transmission of zoonotic helminth parasites especially *A. suum* and *T. suis* which cause infections in humans" (Peng et al., 2007; Bager et al., 2011).

The risk factors predisposing pigs to parasitic infections include age, sex, animal husbandry practices, and geographical location (Geresu et al., 2015; Roesel et al., 2017). Due to a paucity of information on the prevalence and risk factors associated with porcine helminthiasis in different pig farms and rearing systems in Ibadan, this study sought to investigate, determine and quantify various helminth parasites and their prevalence in pig farms under management conditions in selected local government areas of Ibadan, Oyo State, Nigeria.

MATERIALS AND METHODS

Study Area

The areas sampled included three selected local government areas in Ibadan: Akinyele, Ona-Ara, and Egbeda, Oyo State, Southwestern Nigeria. The three selected local government areas are in Oyo Central Senatorial District. Eleven different farms were randomly visited for sample collections with management systems containing large white breeds, and strains of large black, duroc, mixed, and local pigs. The area is known for its tropical wet and dry seasons, a long rainy season, and moderately steady temperatures. The course of the rainy season in the city spans from March to October, although August witnesses a break in rainfall while the dry season is from November to February.

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The average total rain per year in Ibadan city is 1420.06 mm, falling for approximately 109 days with the city undergoing an average highest temperature of 26.46 C with 21.42 as the mean lowest temperature and relative humidity of 74.55 (Christiana et al., 2013). The latitude of Ibadan is 7°22′39″N, and the longitude is 3°54′21″E, 128km Northeast of Lagos and 345km Southwest of the Federal Capital Territory, Abuja (Sowemimo, 2007; Udo, 1994). Sampling took place between November 2020 to March 2021, representing the dry season in Ibadan, Southwestern, Nigeria. The farms selected have four intensively managed farms and seven semi-intensively reared pig farms.

Collection of Fecal Samples

A simple random sampling technique was used to select farms and animals for participation. Freshly voided feces were collected from 246 pigs into sterile, labelled sample bottles containing 10% formalin and kept until analyzed. Location, age, sex, farm type, and health status were recorded for all sampled pigs during the exercise, and samples were examined in the Department of Veterinary Parasitology and Entomology Laboratory, University of Ibadan. Information on farm routine activities and health status were obtained from the farm owners through oral interviews.

Fecal Sample Processing and Examination

Freshly defecated pig fecal samples were collected and processed qualitatively (concentration-flotation and sedimentation techniques) as described by Soulsby (1982). Further, the helminth parasite eggs (EPG) were quantified using the McMaster technique (MAFF, 1986).

Data Analysis

Pearson's chi-square test was applied to determine the relationship between the occurrence of helminth parasites in the sampled pigs and risk factors, such as location, age, sex, farm management practices, and helminth control.

RESULTS

The helminth eggs found in this research work were *Ascaris suum*, *Trichuris suis*, *Oesophagostomum spp*., and *Strongyloides spp*. (see Figure 1). The overall prevalence of helminth parasites in pigs in the selected areas showed that 84 samples representing 34.2% were positive for one or more species of helminth parasites. Of the 246 fecal samples analyzed, 35 (14.26%), 23 (9.3%), 17 (6.9%), and 9 (3.6%) were positive for *Ascaris suum*, *Trichuris suis*, *Oesophagostomum dentatum*, and *Strongyloides ransomi* respectively (see Table 1a).

Also, Table 1b revealed overall single helminth infections prevalence (70.2%) and mixed species infections (29.8%) in selected local government areas. Highest single parasites (73.9%) were detected in Akinyele followed by Ona-Ara (70%) and Egbeda (70%), while the highest helminth parasites load was found in Egbeda (54.7%), followed by Akinyele (25.8%) and least in Ona-Ara (24.4%).

Moreover, the prevalence of helminth parasite load was highest in grower pigs (48.4%) followed by piglets (31.6%) and lowest in adults (22.5%), although there was no significant difference ($p>0.05$) in the rate of infection and the age groups (see Table 2b). Also, the parasite

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burden in female pigs was higher (37.6%) than in male pigs (30.6%) without a significant difference ($p>0.05$) (Table 2c). The semi-intensively managed pig farms (Table 3a) demonstrated a higher prevalence of helminth parasite load (71%) than those under an intensive system (24%) statistical significance ($p<0.05$). Farms that dewormed their pigs had a lower prevalence of helminth parasites load (15%), while there is a presence of high (63%) parasitic load in farms without anthelmintic (see Table 3b) and the result between these two groups was significantly different ($p<0.05$).

Furthermore, Table 4 showed that pigs in Ona-Ara and Akinyele generally voided low (EPG>100) to moderate (EPG>100<500) amounts of helminth eggs, while pigs in Egbeda local government area excreted high (EPG<500<1000) involving *Ascaris suum, Trichuris suis, Oesophagostomum spp*. and *Strongyloides spp.*

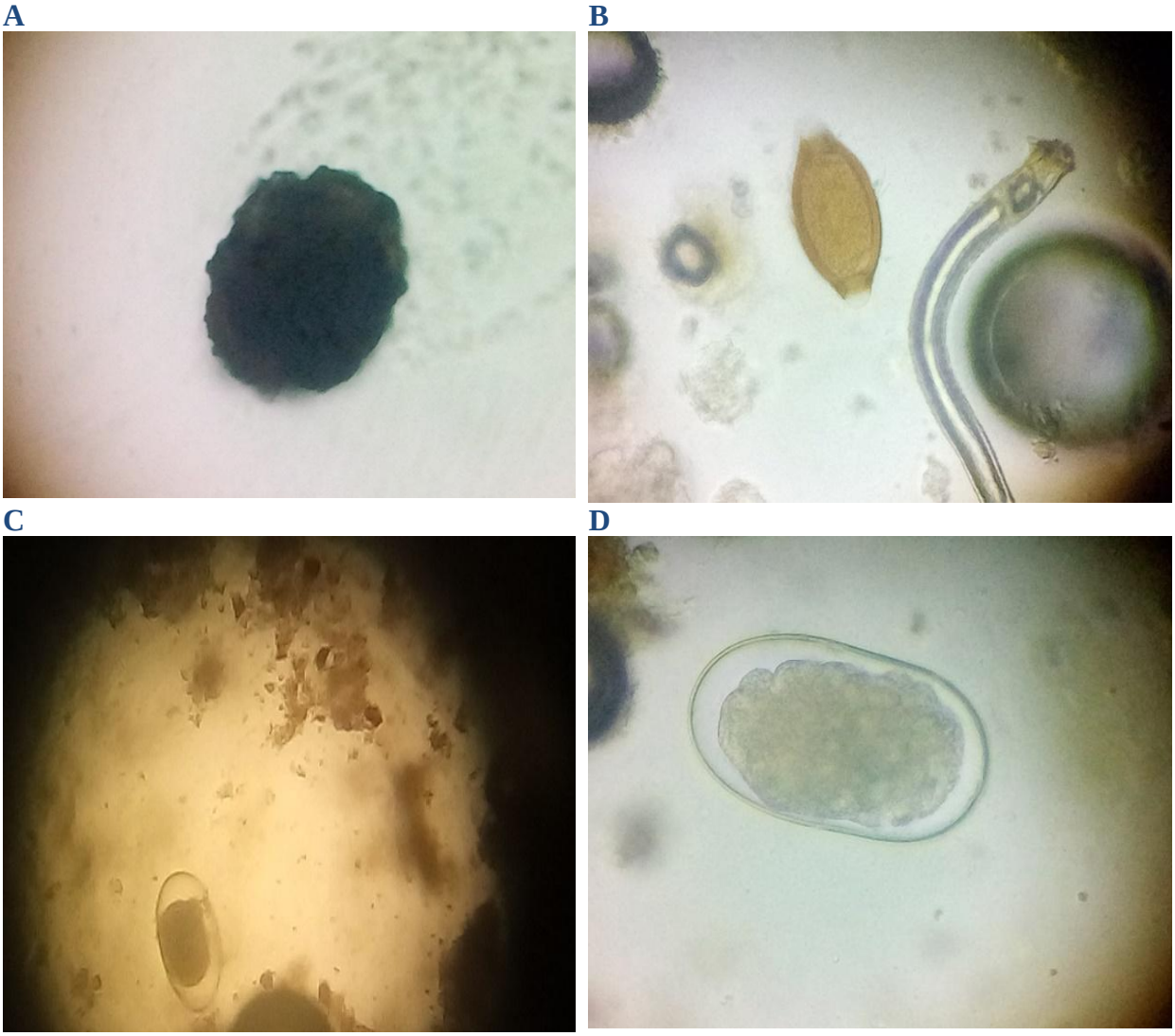

Figure 1: Eggs of gastrointestinal helminth of swine in three selected local government areas, Ibadan. **A**- *Ascaris suum*, **B**- *Trichuris suis*, **C**- *Oesophagostomum spp*, **D**- *Strongyloides spp*

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Table 1a: Overall species prevalence of helminth infections of pigs in selected local government areas of Ibadan.

Helminth species	Total number of samples	Number infected	Prevalence (%)
Ascaris suum	246	35	14.2
Trichuris suis	246	23	9.3
Oesophagostomum dentatum	246	17	6.9
Strongyloides ransomi	246	9	3.6
Fecal samples	246	84	34.2

Table 1b: Co-infection rates of different helminths of pigs in selected local government areas in Ibadan

Location	Single infection (%)	Double infection (%)	Triple infection (%)
Akinyele	17 (73.9)	4 (17.9)	2 (8.7)
Ona Ara	14 (70)	5 (25)	1 (5.0)
Egbeda	28 (70)	9 (22.5)	4 (10)
Total	59 (70.2)	18 (21.4)	7 (8.4)

Table 2a: Prevalence of helminth species infection of pigs in selected locations in Ibadan

		A. Suum	*T. suis*	*O. dentatum*	*S. ransomi*	
Locations	N	n (%)	n (%)	n (%)	n (%)	PL (%)
Akinyele	89	12 (13.5)	7 (7.9)	3 (3.4)	1 (1.1)	23 (25.8)
Ona-Ara	82	7 (8.5)	4 (4.9)	8 (9.8)	1 (1.2)	20 (24.4)
Egbeda	75	16 (21.3)	12 (16)	6 (8.0)	7 (9.3)	41 (54.7)

$X^2 = 18.0915$. *p-value* = 0.02. The result is significant at $p < 0.05$, PL=Parasitic load

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Table 2b: Age group prevalence of helminth species infection of pigs in selected locations in Ibadan

Age (%)	N	A. suum n (%)	T. suis n (%)	O. dentatum n (%)	S. ransomi n (%)	PL
Piglets (0-3)	57	9 (15.8)	6 (10.5)	2 (3.5)	1 (1.8)	31.6
Growers (4-7)	91	16 (17.6)	13 (14.3)	9 (9.8)	6 (6.6)	48.4
Adults (>8)	98	10 (10.2)	4 (4.1)	6(6.1)	2 (2.0)	22.5

$X^2 = 10.4358$, *p*-value = 0.2358, The result is *not* significant at $p < 0.05$, PL=Parasitic load

Table 2c: Sex prevalence of helminths species of pigs in selected locations in Ibadan

Sex	N	*A. suum* n (%)	*T. suis* n (%)	*O. dentatum* n (%)	*S. ransomi* n (%)	PL (%)
Males	121	16 (13.2)	9 (7.4)	10 (8.3)	2 (1.7)	37 (30.6)
Females	125	19 (15.2)	14 (11.2)	7 (5.6)	7 (5.6)	47 (37.6)

$X^2 = 4.1298$. *p*-value =0.39. The result is *not* significant at $p > 0.05$, PL=Parasitic load

Table 3a: Effect of farm management system on prevalence of worm species infection of pigs in selected locations in Ibadan

Farm Management	N	*A. suum* n (%)	*T. suis* n (%)	*O. dentatum* n (%)	*S. ransomi* n (%)	PL (%)
Intensive System	161	11 (6.8)	7 (4.4)	5 (3.1)	1(0.62)	24 (15)
Semi-Int. System	85	24 (28.2)	16 (18.8)	12 (14.1)	8 (9.4)	60 (71)

$X^2 = 35.8348$. *p*-value = 0.00001. The result is significant at $p < 0.05$.

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Table 3b: Effect of anthelmintic administration on helminth species infection of pigs in selected locations in Ibadan

		A. suum	*T. suis*	*O. dentatum*	*S. ransomi*	
Anthelmintic	N	n (%)	n (%)	n (%)	n (%)	PL (%)
Used	147	9 (6.1)	7 (4.8)	5 (3.4)	1 (0.7)	22 (15)
Not used	99	26 (26.3)	16 (16.2)	12 (12.1)	8 (8.1)	62 (63)

$X^2 = 29.2948$, p-value = 0.00001. The result is significant at $p < 0.05$, PL=Parasitic load

Table 4: The infection intensity of helminth parasites of pigs in selected local government areas in Ibadan.

Farm location	Infection intensity (EPG)			
	A. suum	*T. suis*	*O. dentatum*	*S. ransomi*
Akinyele	++	++	+	+
Ona-Ara	++	++	+	+
Egbeda	+++	+++	+++	+

+ = Low EPG (≤100), ++ = Moderate EPG >100 <500), +++ =High EPG (≥500<1000), EPG = Eggs per gramme of faeces

DISCUSSION

Pig farming is a growing animal production in Nigeria, expanding geometrically to support the increasing demands for proteins by the growing population of Nigerians. There are pig producers in all the six geopolitical zones of Nigeria, with the southwest accounting for the highest numbers of pig producers and the least in the northern part of the country due to religious edicts. As profitable as pig production is, one of the impediments to its growth and profitability is helminth parasites infections which most farmers don't take seriously due to a lack of knowledge of the danger associated with helminth infections, such as indigestion, improper absorption of digested foods, occlusion of the intestinal lumen. This research aimed to investigate helminth parasitic infection prevalence in pigs reared under different management systems in three selected local government areas of Ibadan, Oyo State Capital. Reduced overall prevalence observed in this study could be attributed to sampling criteria, type of farm management, provision of a balanced diet, and use of anthelmintic in pigs raised under intensive units. Helminth parasites identified in this study include *Ascaris suum, Trichuris suis, Oesophagostomum species,* and *Strongyloides ransomi.* The most prevalent helminth parasite in this study was *A. suum* (14.2%), followed by *T. suis* (9.3%) which was in contrast to the report by Sowemimo et al. (2012), who recorded *T. suis* as the most prevalent helminth in a

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farm in Ibadan but in agreement with some past research studies who also collected samples from different farms (Sharma et al., 2020; Jufare et al., 2015; Nsoso et al., 2000).

Variation in prevalence could be associated with farm management practice, nutrition, and geographical locations of farms visited. Kagira (2010) and Obonyo et al. (2013) contended that "continuous wet pen houses, dirty surroundings, and favourable environmental temperature increase the rate of infections with *A. suum",* while Sakakibara et al. (2002) demonstrated that "*A. suum* is one of the causes of visceral larva migrans in human beings." Hence, the general public needs sensitization to the zoonotic tendencies of this parasite. The frequency of single infection (70.2%) appeared significantly higher in this study than mixed infections (29.8%). The helminth parasites co-infection phenomenon is due to helminth immunomodulatory activities through the suppression (down-regulation) of the host immune system resulting in immune tolerance and increased susceptibility of the host to mixed helminth infections (Maizels & McSorley, 2016).

T. suis was identified as the second most common helminth in this study with a prevalence of 9.3%. This result slightly concurred with a reported prevalence of 12.2% in Ibadan, 7.8% in Kenya, 6.8 in Botswana, and 4.7% in Zimbabwe (Sowemimo et al., 2012; Obonyo et al., 2012; Nsoso et al., 2000; Morufu et al., 2008), but significantly lower (38%) prevalence in West Indies (Tiwari et al., 2009). The reasons for these differences in those reports across countries could be associated with the time of the year and geographical differences that either favour helminth development or affect their proliferation.

Oesophagostomum species recovered from this work have an overall prevalence of 6.9%, a low level of infection in the areas under survey during the dry season. The result was significantly lower than 25%, 27.2%, and 22.2% recorded for free range, organic and conventional farming systems reported in the Netherlands (Ejick & Borgsteede, 2005). The overall prevalence of *Strongyloides ransomi* was 3.6%, similar to 2.0% reported in Nigeria (Amadi et al., 2018) and 4.2% recorded in Central and Eastern Uganda (Roesel et al., 2017), whereas significantly lower than 39.4% recorded in Rwanda. The differences in prevalence could be associated with weather, pig breed, management system, health, and nutritional status, deworming programme, geographic location, seasonal variation, and environmental hygiene.

Helminth parasite load of 54.7% was observed in Egbeda followed by 25.8% and 24.4% in Akinyele and Ona-Ara local government areas of Ibadan. *A. suum* was most prevalent in Egbeda (21.3%) followed by Akinyele (13.5%) and least in Ona-Ara (8.5%). Also, *T. suis* was highest in prevalence at Egbeda (16%) and least at Ona-Ara (4.9%), *O. dentatum* and *Strongyloides ransomi* were most prevalent in Egbeda (8% and 9.3%) and least in Akinyele 3.4% and 1.1% respectively.

Since there was a dearth of published research in these areas to compare, the type of farm management practiced, number of samples collected, method of preservation before laboratory analysis, and geographical locations were responsible for the variations in helminth parasite infections occurrences. Nwafor et al. (2019) and Nansen and Roepstorff (1999) reported that "farms managed under the semi-intensive system were prone to high levels of helminth infections."

Demographically, the highest helminth parasite infection prevalence was in grower pigs (48.4%), followed by piglets (31.6%), and the lowest in adults (22.5%) with no significance,

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meaning the rate of helminth infections was independent of age. However, the result disagrees with the findings of Sowemimo et al. (2012) who reported the highest helminth prevalence in piglets and least prevalence in grower pigs in Ibadan, Nigeria. The factors responsible for this could be the rate, duration of exposure of grower pigs to eggs and infective stages of the parasites, nutrition, and resistance to helminth disease in adult pigs. However, the prevalence was higher in females (37.6%) than their male (30.6%) counterparts without statistical significance following studies by Tamboura et al. (2006) and Nwafor et al. (2019). This may be because helminths generally have a spectrum.

Farms managed intensively in this current study had an overall 15% prevalence lower than those under semi-intensive systems which was statistically significant ($p<0.05$). Similar situations were reported by Kagira et al. (2010) in Kenya, and Nissen et al. (2011) in Uganda in which "84.2% and 91% in roaming and free-range pigs." "Intensively raised pigs have been observed to record lower helminth infection rates" (Liu and Lu, 2002) as found in this work. The reduction could be associated with proper hygiene practice, biosecurity measures put in place, systematic deworming programme, and daily cleaning and removal of excrements whereas, poor animal husbandry, lack of biosecurity measures observed in semi-intensive farms visited were probably responsible for higher helminth prevalence in the semi-intensive system.

This study showed a significant difference ($p<0.05$) in the prevalence of helminth parasites between farms where anthelmintic was administered (15%) compared to 63% prevalence found in pigs that were not dewormed because the farmers did not see any need for it. In most intensive farms visited for sample collection, a deworming programme with good hygiene and daily cleaning of pen houses could be the reason for the low helminth prevalence. However, pigs that grazed around have higher tendencies of being infected with helminth parasites.

The eggs per gramme (EPG) of faeces examined in this study ranged between low (epg<100) to moderate (epg>100<500) levels of helminth parasites in all the local government areas except in Egbeda local government area with high (epg>500<1000) of *A. suum*, *T. suis*, and *O. dentatum* eggs. The low to moderate EPG recorded in Akinyele and Ona-Ara could be because the helminth parasites infections were at a prepatent period or due to seasonal variation (dry season) and may not be suitable for helminths propagation and development which result in "moderately subclinical infection described to be a severe form of infection leading to reduced production performance and economic losses" (Marufu et al., 2008).

CONCLUSION AND RECOMMENDATIONS

The overall prevalence rate of helminth infections in three local government areas of Ibadan, Oyo State, southwestern Nigeria was 34.2% with A. suum (14.26%) predominating. The main predisposing factors to helminth parasites in this study were the use of anthelminthic and management system practices which had a significant ($p<0.05$) consequence on the swine helminth diseases. Therefore, routine cleaning of faeces and other manure from pigs' houses, restriction of pigs from roaming or grazing around and proper use of deworming programmes will further reduce the rate of helminth parasitic diseases.

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conflict of interest

Authors declare no conflict of interest.

REFERENCES

Abiola J. O., Omotosho O. O., Adeniyi O. M., Ayoade G. O. (2015): "Socio-demographic Characteristics of Swine Producers and Swine Management Practices in Ibadan, Oyo State, Nigeria." Alexandria Journal of Veterinary Sciences 47 (1):18–23.

Adetunji M. O., Adeyemo K. E. (2012): "Economic efficiency of pig production in Oyo State, Nigeria: a stochastic production frontier approach." American Journal of Experimental Agriculture 2(3): 382 – 394.

Ajala M. K., Adesehinwa A. O. K., Mohammed A. K. (2007): "Characteristics of smallholder pig production in Southern Kaduna area, Kaduna State, Nigeria." American-Eurasian Journal of Agriculture and Environmental Science 2 (2007): 182 – 187.

Åkerfeldt M. P., Gunnarsson S., Bernes G., Blanco-Penedo I., (2021): "Health and welfare in organic livestock production systems-a systematic mapping of current knowledge," Organic. Agriculture (2021) 11:105–132) https://doi.org/10.1007/s13165-020-00334-y

Akpan S. J. (2016): "The influence of cultural factors on consumer buying behaviour (a case study of pork)." British Journal of Marketing Studies. 4 (6) 44-57.

Amadi, A. N., Ubiaru, P. C., Ugagu, G. M., Ibediugha, B. N., Obeagu, I. A., Njikeonye, A. (2018) "Preliminary study on the prevalence of gastrointestinal parasites of pigs managed and slaughtered in Umuahia North local government area of Abia State, Nigeria." Animal Research International (2018) 15 (2): 3013 – 3019

Bager P., Kapel C., Roepstorff A., Thamsborg S., Arnved J, et al. (2011) "Symptoms after Ingestion of Pig Whipworm *Trichuris suis* Eggs in a Randomized Placebo-Controlled Double-Blind Clinical Trial." PLoS ONE 6 (8): e22346. doi: 10.1371/journal.pone.0022346

Christiana N, Egbinola and Amanambu C. A (2013); "Climatic variation Assessment based on rainfall and temperature in Ibadan, south western Nigeria," Journal of environmental earth science 3 No. 11

Dey T. R., Dey A. R., Begum N., Akther S. Barmon B. C., (2014) "Prevalence of endoparasites of pig at Mymensingh, Bangladesh", Journal of Agriculture and Veterinary Science 7(4), 31–38. https://doi.org/10.9790/2380-07433138

Eijck I. & Borgsteede F., (2005) "A survey of gastrointestinal pig parasites on free-range, organic and conventional pig farms in the Netherlands", Veterinary Research Communications 29, 407–414. http://dx.doi.org/10.1007/s11259-005- 1201-z, PMid:16195935

FAO. (2019) "The future of livestock in Nigeria. Opportunities and challenges in the face of uncertainty."

FMARD. (2017) "Animal population data. Federal Ministry of Agriculture and Rural Development."

Geresu M. A., Hailemariam Z., Mamo G., Tafa M., Megersa M. (2015): "Prevalence and associated risk factors of major gastrointestinal parasites of pig slaughtered at Addis Ababa Abattoirs Enterprise", Ethiopia. J Vet Sci Technol, 6: 4 – 11

Article DOI: 10.52589/AJBMR-VIAGGSSE
DOI URL: https://doi.org/10.52589/AJBMR-VIAGGSSE

Jufare, A., Awol, N., Tadesse, F., Tsegaye, Y. & Hadush, B., (2015) "Parasites of pigs in two farms with poor husbandry practices in Bishoftu, Ethiopia", Onderstepoort Journal of Veterinary Research 82(1), Art. #839, 5 pages. http://dx.doi.org/10.4102/ojvr.v82i1.839

Kagira J. M., (2010) "Characteristics of production system, epidemiology and control of pig parasites in Busia District, Kenya", PhD Thesis, University of Nairobi, Kenya.

Kagira J. M., Kanyari, P. N., Githigia, S. M., Maingi, N., Nganga, J. C. & Gachohi, J. M. (2012) "Risk factors associated with occurrence of nematodes in free range pigs in Busia District, Kenya," Tropical Animal Health and Production 44, 657–664. http://dx.doi.org/10.1007/s11250-011-9951-9, PMid:21833678

Kumsa B, Tolera, A. & Nurfeta, A. (2010) "Comparative efficacy of seven brands of albendazole against naturally acquired gastrointestinal nematodes in sheep in Hawassa, southern Ethiopia", Turkish Journal of Veterinary and Animal Sciences 34, 417–425.

Liu C. Q., Lu J. (2002). "Investigation on the prevalence of parasites in intensively raised pigs in Yulin Administrative Region, Guangxi Zhuang Nationality Autonomous Region, People's Republic of China." Guangxi J. Anim. Sci. Vet. Med. 18 (6): 11-12.

MAFF (1986): "Manual of Veterinary Parasitological Laboratory Techniques", Her Majesty Stationery Office, HMSO, London.

Maizel R. M. and McSorley H. J., (2016) "Regulation of the host immune system by helminth parasites", Journal of Allergy and Clinical Immunology; 138 (3): 666–675.

Marufu, M. C., Chanayiwa, P., Chimonyo, M., Bhebhe, E. (2008): "Prevalence of gastrointestinal nematodes in Mukota pigs in a communal area of Zimbabwe." African. J. Agri. Res., 3: 91 – 95

Nansen P., Roepstorff A. (1999). "Parasitic helminths of the pig: factors influencing transmission and infection levels." Int J Parasitol. 29:877–891.

Nissen S, Poulsen I. H., Nejsum P, Olsen A, Roepstorff A, Rubaire-Akiiki C, Thamsborg S. M. (2011) "Prevalence of gastrointestinal nematodes in growing pigs in Kabale District in Uganda." Trop. Anim Health Prod 43:567–572. doi:10.1007/s11250-010-9732-x

Nganga, C. J., Karanja, D. N. & Mutune, M. N. (2008) "The prevalence of gastro-intestinal helminth infections in pigs in Kenya", Tropical Animal Health and Production 40, 331–334. https://doi.org/10.1007/s11250-007-9112-3

Nsoso, S. J., Mosala, K. P., Nidebele, R. T. and Ramabu, S. S. (2000). "The prevalence of internal and external parasites in pigs of different age and sexes in southeast district, Botswana." Onderstepoort J. of Vet. Res., 67,217-220

Nwafor I. C., Roberts H. Fourie P. (2019) "Prevalence of gastrointestinal helminths and parasites in smallholder pigs reared in the central Free State Province", Onderstepoort Journal of Veterinary Research 86 (1), a1687. https://doi. org/10.4102/ojvr.v86i1.1687

Obonyo F., Maingi N., Githigia S., Nganga C. (2013) "Farming practices and risk factors for transmission of helminths of free range pigs in Homabay District, Kenya." Livest Res Rural Dev 25:36, http://www. lrrd.org/lrrd25/3/bon25036.htm.

Okorafor U. P., Unigwe C. R., Okorafor J. C., Isegbe E. I., Ogbu U. M. and Atoyebi T. J. (2014) "A Survey of Gastrointestinal Parasites of Pigs that Arrived for Slaughter at Bodija Abattoir, Ibadan, Oyo State, Nigeria". Int. J. Pure Appl. Sci. Technol., 20(2), pp. 53-57

Osondu C. K., Ijioma J. C., Anyiro C. O., Obike K. (2014): Economic Analysis of Pig Production in Abia State, Nigeria. International Journal of Applied Research and Technology 3(3):3– 10.

Article DOI: 10.52589/AJBMR-VIAGGSSE
DOI URL: https://doi.org/10.52589/AJBMR-VIAGGSSE

Peng W, Yuan K, Hu M, Gasser R. B, (2007) "Recent insights into the epidemiology and genetics of Ascaris in China using molecular tools." Parasitology. 2007. p. 325–30.

Roesel K., Dohoo, I., Baumann M., Dione M., Grace D., Clause P.H. (2017) "Prevalence and risk factors for gastrointestinal parasites in small-scale pig enterprises in Central and Eastern Uganda." Parasitol. Res. 116: 335 – 345. DOI: 10.1007/s00436-016-5296-7

Shaibu, B., Ahiju, A and J.S. Bakshi (1997). "Nigerian National Agricultural Research Strategy Plan:1996-2010." Department of Agricultural Sciences. Federal Ministry of Agriculture and Natural Resources, Abuja.

Sharma D., Singh N. K., Singh H., Rath S. S. (2020): "Copro-prevalence and risk factor assessment of gastrointestinal parasitism in Indian domestic pigs." Helminthologia, 57(1):28 – 36.

Soulsby, E.J.L. (1982): "Helminths, Arthropod and Protozoa of Domesticated Animals", 7th edn, Bailliere Tindal, London, pp. 136 –346, 593 – 614, 763 – 778

Sowemimo O. A. (2007). "Toxocariasis and other intestinal helminth infections in dogs in Ile-Ife and Ibadan, Southwest Nigeria." PhD. Dissertation, Obafemi Awolowo University, Ile- Ife, Nigeria.

Sowemimo O. A., Asaolu S. O., Adegoke F. O., Ayanniyi O. O. (2012) "Epidemiological survey of gastrointestinal parasites of pigs in Ibadan, southwestern Nigeria." Journal of public health and epidemiology, 4(10): 294-298

Tamboura H. H., Banga-Mboko H., Maes D., Youssao I., Traore A., Bayala B., Dembele M. A. (2006). "Prevalence of common gastrointestinal nematode parasites in scavenging pigs of different ages and sexes in Eastern Centre Province, Burkina Faso." Onderskpoort J. Vet. Res. 73:53-60

Tiwari K. P., Chikweto A., Belot G., Vanpee G., Deallie C., Stratton G., Sharma R. N. (2009). "Prevalence of intestinal parasites in pigs in Grenada, West Indies." West Indian Vet. J. 9(1):22-27.

Udo R. K. (1994). "Ibadan in its Regional Setting." In: M. O., Akintola F. O., Ikporukpo C. O. (eds.), Ibadan Region. Filani, Rex Charles Publication in association with Connel Publications, Ibadan. pp. 8-17.

Ugbomoiko, U. S., Ariza L., Heukelbach J. (2008): "Pigs are the most important animal reservoir of Tunga penetrans (jigger flea) in a rural Nigeria". Tropical Doctor 38(4): 226 – 227. Doi:10.1258/td.2007.070352

Weka R. P. and Ikeh E. I. (2009) "Seroprevalence of cysticercosis and intestinal parasitism of pigs in Jos Metropolis." Journal of animals and Veterinary advances 8 (5): 883-887

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DOI URL: https://doi.org/10.52589/AJBMR-VIAGGSSE