ECTOPARASITES AND ENDO-HELMINTHS FROM PIGS IN ABAKALIKI AND IZZI LOCAL GOVERNMENT AREAS, EBONYI STATE, NIGERIA

[1]ELOM, Michael Okpara, [1]UKAEGBU, Philip Kelechukwu, [2]ELOM, Ogbonnaya and [3]OKPARA-ELOM, Ifeoma Anthonia

[1]Department of Medical Laboratory Science, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria.
[2]Department of Agricultural Education, Ebonyi State College of Education, Ikwo, Ebonyi State, Nigeria.
[3]Department of Applied Microbiology, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria.

Corresponding Author: Elom, M. O. Department of Medical Laboratory Science, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria. **Email:** michaelokpara147@gmail.com **Phone:** +234 8063493565

Received *November 1, 2021;* ***Revised*** *December 8, 2021;* ***Accepted*** *December 10, 2021*

ABSTRACT

Parasitism affects output in pig production and introduces high risks of diseases. This study investigated ectoparasites and endo-helminths of pigs in Abakaliki and Izzi Local Government Areas (LGAs) of Ebonyi State, Nigeria. One hundred and sixty eight (168) pigs were examined for both ecto- and faecal parasites. Snowball and simple random sampling techniques were employed in the study. Faecal samples collected using appropriate procedures were processed and examined using concentration techniques. Collection and processing of ectoparasites followed standard parasitological procedures. The recovered parasites were identified using morphological characteristics and standard guides. Data collected were analysed using descriptive statistics and Chi-square. Statistical significance was established at p<0.05. Overall, 44 pigs (26.1 %) were infested with ectoparasites. Pigs were infested most with Ctenocephalides canis (9.52 %) and least with Haemaphysalis species (1.79 %). There was significant difference (p = 0.042) in prevalence of C. canis with respect to sex. Sixty eight pigs (40.48 %) were infected with faecal parasites. Ascaris suum had the highest overall prevalence (17.86 %) while Taenia solium had the least (1.79 %). There was no significant difference between faecal parasite infection and age of pigs (p>0.05). However, a significant association (p = 0.026) was established between sex of pigs and infection with Fasciola hepatica. Thirteen (7.74 %) and 14(8.33 %) of the pigs were infested and infected respectively with more than one parasite taxa. Parasitism increased with advancement in age of pigs. Adequate utilization of veterinary services, good sanitation and proper training of farmers are recommended.

Keywords: Pigs, Ectoparasites, Endo-helminths, Ebonyi State

INTRODUCTION

Pig production enhances food security, reduces poverty and creates employment opportunities (Otte *et al*., 2012; H**e**rrero *et al*., 2013). However, this great enterprise could be hazardous if not carefully undertaken as many known pig-borne zoonotic infections could be contracted (Olson and Guselle, 2000; Dadas *et al*., 2016) through contact with the animals, their products or from environment of poor sanitation standard. Infections and diseases that are naturally transmitted between vertebrates and man are regarded as zoonotic (Park, 2009). Zoonotic ectoparasites of public health importance include, *Sarcoptes scabiei* var *suis* Linnaeus, 1758 (Sarcoptiformes: Sarcoptidae) (Grahofer *et al*., 2018), lice, fleas, ticks and

mites (Braae *et al*., 2013). *Ascaris suum* Goeze, 1782 (Ascaridida: Ascarididae), *Trichuris suis* Schrank, 1788 (Trichocephalida: Trichuridae), *Fasciola hepatica* Linnaeus, 1758 (Plagiorchiida: Fasciolidae) among others, are important zoonotic intestinal parasites. These parasites have been known to be a great burden to the pigs and the farmers especially in places where poor sanitation prevails and free range farming system is practiced.

In order to avoid being infested and/ or infected with any of the zoonotic parasites, appropriate biosecurity measures are required to be taken. Biosecurity has been technically defined as the implementation of measures that reduce the risk of introduction and transmission of pathogens (FAO, 2008). A set of attitudes, behavior and practices have been recommended to be in place so that risks will be minimized in all activities that involve domestic (including pigs), captive, exotic and wild animals and their products (FAO, 2008). Segregation, cleaning and disinfection, the three basic principles of biosecurity are important in livestock farms. However, investment in effective control of livestock zoonotic infections and diseases has been reported to be always inadequate especially in the developing countries of the world (FAO, 2010).

Pig production system has been categorized into scavenging pigs, small scale pig production, large scale confined pig production and large scale outdoor pig production (Wikipedia, 2021). The scavenging system has been phased out and replaced by the intensive system, a modern rearing system which can be in small scale or large scale production.

Many documented information on parasitism and swine health are available but majority of the available literature emphasized swine parasitism as it affects only the health of the animals alone, ignoring the fact that the interactions that exist between the animals and the farmers could predispose the farmers to some health problems. Many studies address swine parasitism in Nigeria. Therefore, the aim of this study was to provide in-depth information on pig parasitic infections in the studied Local Government Areas (LGAs) of Ebonyi State.

MATERIALS AND METHODS

The Study Area: The study was carried out in Abakaliki (6.3231° N, 8.1120° E) and Izzi (6.5529° N, 8.2651° E) LGAs of Ebonyi State. Izzi LGA is close to Abakaliki, the state capital (GEODATOS, 2021). The vegetation characteristic of the study areas is tropical rainforest. The state is an agrarian state that produces many kinds of crop and rears different livestock, especially pigs, majority being at small-holder scales. Rearing of pigs is encouraged in the state because of the high crop yields, as most pig farmers feed their animals from the peelings and refuse from the crops (Jiwuba *et al*., 2019). Wet and dry seasons are the two predominant seasons in the area. The wet season commences by April and ends by October whereas the dry season begins by November and ends in March (Ifediegwu *et al*., 2019; Usuwa *et al*., 2020).

Ethical Considerations: Permission and oral informed consent were obtained from the pig breeders before their animals were examined for parasites.

Sampling Techniques: Snowball sampling technique was used to arrive at farms studied in the two LGAs whereas simple random sampling technique was used to select the examined animals from each farm. The number of animals examined from each farm was proportional to the size of the farm.

Collection of Faecal Specimen: Faecal specimen was collected according to the procedure outlined by Soulsby (1982) and Bhatia *et al.* (2012). Faecal specimen was collected from the rectum of each pig, using the index finger under a properly worn latex glove. In situations when it was not possible to collect enough faecal matter from the rectum, the surface of a freshly passed faeces from the animal was carefully collected so as to avoid contaminating it with the soil. The specimen was inserted into a screw cap wide-mouthed container, containing 10 % formalin and was immediately transported to the laboratory.

Faecal Processing and Examination: Concentration techniques involving both centrifugal floatation method and centrifugal sedimentation method were used in processing of each of the faecal specimen.

Centrifugal floatation method: Five (5) gram of faeces was dissolved in water using pestle and mortar and strained. Thereafter, the specimen was made up to 10 ml and was transferred into a 15 ml centrifuge tube and was centrifuged at 200 rpm for 2 minutes. The supernatant was removed and centrifugation was repeated 2 more times. After the third centrifugation, the residue was mixed with saturated sodium chloride solution in a test tube and was filled up to the brim with the salt solution. The preparation was covered with a clean round coverslip and was left standing in a vertical position for 2 minutes. Thereafter, the coverslip was gently removed and placed on a clean grease-free microscope slide and examined under the microscope, using X_{10} and X_{40} objective lenses respectively (Bhatia *et al.*, 2012).

Centrifugal sedimentation method: Five (5) gram of faeces was dissolved in water. Thereafter, it was strained and transferred to a 15 ml centrifuge tube. More water was added to the preparation to make it up to 10 ml (2/3 of the capacity of the centrifuge tube). The preparation was allowed to stand for 5 minutes. The supernatant was carefully decanted and the sediment was examined under the microscope, using X_{10} and X_{40} objective lenses (Bhatia *et al.*, 2012).

Collection and Processing of Ectoparasites: The entire body surface of each pig was inspected for the presence of ectoparasites. The body surface hair was brushed and properly examined for any ectoparasites. The procedure adopted followed Wall and Shearer (2001) and Bhatia *et al.* (2012).

Collection, Processing and Examination of Ticks and Fleas: Ticks were carefully detached from the body of each animal, with the use of sterilized forceps, ensuring that the entire mouthparts were removed. The recovered ticks and fleas were inserted into well-labeled specimen containers that contained 70 % alcohol and were transported to the Teaching and Research Laboratory of the Department of Medical Laboratory Science, Ebonyi State University, Abakaliki, for examination. A highly magnified hand lens was used to examine the morphological features of both dorsal and ventral surfaces of the ticks and fleas. Thereafter, each of them was transferred to a slide and re-examined under the microscope for clearer identification.

Collecting, Processing and Examination of Mites: The skin of the affected parts of the body of each pig was scrapped, using a sterilized blunt scapel blade. The skin scrap was collected into a Petri dish whose edges were smeared with Vaseline. Ten per cent (10 %) KOH was applied to the material to dissolve the debris and hair. The preparation was then transferred into a centrifuge tube and was centrifuged three times, using water. Thereafter, it was then dehydrated in ascending grades of alcohol and the supernatant was decanted. Xylene was then added to clear it. A drop of the sediment was transferred to the microscope slide, using a dropping pipette. Dibutylphthalate polystyrene xylene (DPX) was added and it was covered with a coverslip and examined under the microscope. The species of mites recovered were also appropriately identified and recorded in a data notebook.

Identification of Parasites: The recovered parasites were identified using morphological characteristics and some identification guides as outlined by Wall and Shearer (2001) and Bhatia *et al.* (2012).

Statistical Analysis: Data collected was analyzed using descriptive statistics and Chi-square. Levels of significance were set at $p<0.05$.

RESULTS

The population characteristics of examined pigs across the studied farms indicated that the least number of pigs examined was from farm G with 17 pigs. The highest number of pigs was from farm C with 29 pigs. Female pigs were more in number (93) than their male (75) counterparts (Table 1).

Table 1: Population characteristics of pigs across studied farms in Abakaliki and Izzi Local Government Areas of Ebonyi State, Nigeria

Age (Months)	Number Examined	Farms						
		A	B	C	D	E	F	G
≤ 5	42	6	7	6	5	6	7	5
6 – 10	61	9	10	10	8	9	8	7
≥ 11	65	8	9	13	10	13	7	5
Total	168	23	26	29	23	28	22	17
Sex								
Males	75	10	12	14	9	16	10	7
Females	93	13	14	15	14	12	12	10

The prevalence of ectoparasites among the studied pigs in relation to age and sex indicated that 44 pigs were infested with ectoparasites, with prevalence of 26.1 % (Table 2). With respect to age, the pigs were infested most by *Ctenocephalides canis* Curtis, 1826 (Siphonaptera: Pulicidae) with prevalence of 9.52 %, while *Haemaphysalis* spp. Koch, 1844 (Ixodida: Ixodidae) had the least prevalence of 1.79 %. *Rhipicephalus appendiculatus* Neumann, 1901 (Ixodida: Ixodidae) was moderately prevalent (7.14 %). There was no significant difference in prevalence of parasites with respect to age. Except in infestation with *Haemaphysalis* spp. where the females were infested more than the males (2.15 vs. 1.33 %), the prevalence of every other parasite was higher among the males. There was significant difference (p = 0.042) in prevalence of *C. canis* with respect to sex.

The age and sex related prevalence of endo-helminths among the studied pigs is as depicted in Table 3. Overall, sixty eight pigs were infected with faecal parasites, with infection prevalence of 40.48 %. According to age and sex, *A. suum* had the highest overall prevalence (17.86 %), whereas *T. solium* had the least (1.79 %). There was no significant difference (p>0.05) between endo-helminths infections and age of pigs. However, a significant association (p = 0.026) was established between sex of pigs and infections with *F. hepatica*, with males infected more than the females.

Overall, double infestations and infections had higher prevalence than multiple infestations and infections (5.36 and 6.55 %) vs. (2.38 and 1.79 %) respectively (Table 4). Thirteen (7.74 %) and 14(8.33 %) of the pigs were infested and infected respectively with more than one parasite taxa. However, no significant statistical association (p>0.05) was established with respect to age, sex, ectoparasitic infestations and endo-helminth infections among the studied pigs.

DISCUSSION

The study was carried out to determine the prevalence of ectoparasites and endo-helminths of pigs in Abakaliki and Izzi LGAs of Ebonyi State. Four taxa of ectoparasites – *C. canis*, *S. scabiei, R. appendiculatus* and *Haemaphysalis* spp., were recovered. Hookworms, *A. suum, T. suis, F. hepatica* and *T. solium,* were the species of endo-helminths recovered from the pigs.

The pigs were found to be infested most by *C. canis* and least infected by *Haemaphysalis* spp. Infestation of pigs by the ectoparasites increased with advancement in age, with pigs' ≤ 5 months old being least infested. This observation differed from reports of earlier study by Das *et al.* (2010), who reported sarcoptic mange, caused by *S. scabiei* var *suis* as the most prevalent ectoparasites of pigs in a hilly region of Meghalaya. However, the finding that older pigs were infested more than the younger ones agreed with the reports of Maganga *et al.* (2019) in pigs from South East Garbon, Central Africa and Jufare *et al.* (2015) in pigs farmed in Bishaftu, Ethiopia.

Among the recovered endo-helminths, *A. suum* was found to have the highest overall prevalence. The finding of this study agreed with Tamboura *et al.* (2006), who reported *A. suum* as the most prevalent faecal parasite in Burkina Faso.

Table 2: Age and sex related prevalence of ectoparasites among the studied pigs from farms in Abakaliki and Izzi Local Government Areas of Ebonyi State, Nigeria

Age (months)	Number examined	Parasites species			
		Ctenocephalides canis	*Sarcoptes scabiei*	*Rhipicephalus appendiculatus*	*Haemaphysalis* spp.
		Number Infected (%)	Number Infected (%)	Number Infected (%)	Number Infected (%)
≤ 5	42	3(7.14)[a]	1(2.38)[a]	1(2.38)[a]	0(0.00)[a]
6 – 10	61	5(8.20)[b]	3(4.92)[b]	4(3.28)[b]	2(3.28)[b]
≥ 11	65	8(12.31)[c]	9(13.85)[c]	7(1.54)[c]	1(1.54)[c]
Total	168	16(9.52)	13(7.74)	12(7.14)	3(1.79)
Sex					
Males	75	11(14.67)*	9(12.00)*	7(9.33)*	1(1.33)
Females	93	5(5.38)	4(4.30)	5(5.38)	2(2.15)*
Total	168	16(9.52)	13(7.74)	12(7.14)	3(1.79)

*Values with different superscript letter on the same column are statistically significantly different (p<0.05), *significantly different (p<0.05) values using pairwise comparisons of females and males on the same column*

Table 3: Age and sex related prevalence of endo-helminths among the studied pigs from farms in Abakaliki and Izzi Local Government Areas of Ebonyi State, Nigeria

Age (Months)	Number examined	Parasitic taxa/species				
		Hookworm	*Ascaris suum*	*Trichuris Suis*	*Fasciola hepatica*	*Taenia solium*
		Number infected (%)	Number infected (%)	Number infected (%)	Number infected (%)	Number infected (%)
≤ 5	42	1(2.38)[a]	9(21.43)[a]	2(4.76)[a]	0(0.00)[a]	0(0.00)[a]
6 – 10	61	6(9.84)[b]	8(13.12)[b]	6(9.84)[b]	2(3.28)[b]	0(0.00)[b]
≥ 11	65	10(15.39)[c]	13(20.00)[c]	3(4.62)[c]	5(7.69)[c]	3(4.62)[c]
Total	168	17(10.12)	30(17.86)	11(6.55)	7(4.17)	3(1.79)
Sex						
Males	75	6(8.00)	11(14.67)	7(9.33)*	6(8.00)*	3(4.00)*
Females	93	11(11.83)*	19(20.43)*	4(4.30)	1(1.08)	0(0.00)
Total	168	17(10.12)	30(17.86)	11(6.55)	7(4.17)	3(1.79)

*Values with different superscript letter on the same column are statistically significantly different (p<0.05), *significantly different (p<0.05) values using pairwise comparisons of females and males on the same column*

Table 4: Age and sex related prevalence of co-infestations and co-infections among the studied pigs from farms in Abakaliki and Izzi Local Government Areas of Ebonyi State, Nigeria

Age (Months)	Number Examined	Ectoparasites		Endo-helminths	
		Ctenocephalides canis + Sarcoptes scabiei (%)	*Sarcoptes scabiei + Rhipicephalus appendiculatus + Ctenocephalides canis (%)*	*Ascaris suum + Hookworm (%)*	*Ascaris suum +Trichuris suis + Fasciola hepatica (%)*
≤ 5	42	4(9.52)[a]	1(2.38)[a]	4(9.52)[a]	0(0.00)[a]
6 – 10	61	2(3.23)[b]	1(1.64)[b]	3(4.92)[b]	0(0.00)[b]
≥ 11	65	3(4.62)[c]	2(3.08)[c]	4(6.15)[c]	3(4.62)[c]
Total	168	9(5.36)	4(2.38)	11(6.55)	3(1.79)
Sex					
Males	75	6(8.00)*	3(4.00)*	4(5.33)	1(1.33)
Females	93	3(3.23)	1(1.08)	7(7.53)*	2(2.15)*

*Values with different superscript letter on the same column are statistically significantly different (p<0.05), *significantly different (p<0.05) values using pairwise comparisons of females and males on the same column*

Singh *et al*. (2017) and Nwafor *et al.* (2019) also reported *A. suum* as the most prevalent faecal parasite in pig in and around Jabalpur, Madhya Pradesh, India and in the Central Free State Province, South Africa, respectively. However, the findings of the present study differed from Inpankaew *et al*. (2015), who reported *Fasciolopsis buski* Looss, 1899 (Plagiorchiida: Fasciolidae) as the most prevalent faecal parasites of pigs in Cambodia. The prevalence of *A. suum* observed in this study was higher than 4.9, 11.1 and 12.7 % reported by Tiwari *et al.* (2009), Sowemimo *et al*. (2012) and Jufare *et al*. (2015). It is interesting to note that *A. suum* is a serious pig-borne parasite that is presently highly being considered zoonotic. The parasite is known to affect both indoor and outdoor pig production. It is possibly the most persistent and most resistant to adverse environmental conditions. The thick and resistant nature of the eggshell has been understood to enhance its protection from adversity with respect to environment, desiccation and chemicals. It has been reported that *A. suum* is among the parasites that cause visceral larvae migrans and other pathological cases in humans (Sakakibara *et al*., 2002; Kakihara *et al*., 2004).

That a significant association exists between sex of pigs and infections with *F. hepatica* was in line with the findings of Sowemimo *et al.* (2012). However, this finding does not agree with Maganga *et al.* (2019), who reported no significant difference in parasite infestation in the studied pigs.

In the present study, no statistical association was established with respect to age, sex and ectoparasites. *A. suum* was found to be more prevalent among pigs in the present study in comparison with some other reported findings elsewhere. The observed difference in parasitism could be attributed to the fact that the studies were carried out in different geographical settings with possible varying environmental, hygienic and rearing practices. Pigs raised under the free range system have been known to feed more regularly upon raw garbage that might be contaminated with parasites in the field, kitchen waste, and faecal matter, in places where open defecation is being practiced, rendering them more susceptible to parasitic infections. In addition, the prevailing environmental condition of the study areas of the present study is characterized by high temperature and humidity, conditions that favour the survival and thriving of some nematodes including *Ascaris* species. Sex, age, management practices, season, geographical location and levels of farmers' awareness have severally been reported to be among the risk factors that determine levels of parasitism in pigs (Nwafor *et al*., 2019).

Conclusion: Pig parasitism is a global veterinary and human public health problem that has adverse economic and health consequences on the affected countries. Emphasis on use of intensive systems, regular training of farmers and involvement of veterinarians are recommended. Health policy issues that emphasize One Health Agenda should be implemented in order to ensure both swine and human health. Proper examination of pig farmers for potential harbouring of the parasite species recovered from pigs in this study is recommended.

ACKNOWLEDGEMENTS

The authors thank the pig farmers in the studied areas for their cooperation during the study by allowing us to examine the animals.

REFERENCES

BHATIA, B. B., PATHAK, K. M. L. and JUYAL, P. D. (2012). *Textbook of Veterinary Parasitology.* Kalyani Publishers, Ludhiana, New Delhi, India.

BRAAE, U. C., NGOWI, H. A. and JOHANSEN, M. V. (2013). Smallholder pig production: prevalence and risk factors of ectoparasites. *Veterinary Parasitology*, 196(1-2): 241 – 244.

DADAS, S., MISHRA, S., JAWALAGATTI, V., GUPTA, S., VINAY, T. S. and GUDEWAR, J. (2016). Prevalence of gastrointestinal parasites in pigs (*Sus sucrofa*) of Mumbai Region. *International Journal of*

Science, Environment and Technology, 5(2): 822 – 826.

DAS, M., LAHA, R., DEVI, P., BORDOLOI, R. K. and NASKAR, S. (2010). Sarcoptic mange infestation in pigs in a hilly region of Meghalaya. *Tropical Animal Health and Production*, 42(5): 1009 – 1011.

FAO (2008). *Biosecurity for Highly Pathogenic Avian Influenza: Issues and Options*. Food and Agriculture Organization (FAO) Animal Production and Health Paper, Rome, Italy. https://www.fao.org/3/i0359e/i0359e00.pdf

FAO (2010). *Good Practices for Biosecurity in Pig Sector: Issues and Options in Developing and Transition Countries*. Food and Agriculture Organization (FAO) Animal Production and Health Paper Number 169, FAO, Rome, Italy. https://www.fao.org/3/i1435e00.pdf

GEODATOS (2021). *Abakaliki Geographic Coordinates.* Geodataos.net https://www.geodataos.net/en/coordinates/nigeria/abakaliki

GRAHOFER, A., BANNOEHR, J., NATHUES, H. and ROOSJE, P. (2018). Sarcoptes infestation in two miniature pigs with zoonotic transmission – a case report. *BMC Veterinary Research*, 14: 91. https://doi.org/10.1186/s12917-018-1420-5

HERRERO, M., GRACE, D., NJUKI, J., JOHNSON, N., ENAHORO, D., SILVESTRI, S. and RUFINO, M. C. (2013). The roles of livestock in developing countries. *Animal*, 7(s1): 3 – 18.

IFEDIEGWU, I. S., ONYEABOR, C. F. and NNAMANI, C. M. (2019). Geochemical evaluation of carbonate aquifers in Ngbo and environs, Ebonyi State, southeastern, Nigeria. *Modeling Earth Systems and Environment*, 5(4): 1893 – 1909.

INPANKAEW, T., MURRELL, K. D., PINYOPANUWAT, N., CHHOUN, C., KHOV, K., SEM, T., SORN, S., MUTH, S. and DALSGAARD, A. (2015). A survey for potentially zoonotic gastrointestinal parasites of dogs and pigs in Cambodia. *Acta Parasitologica*, 60(4): 601 – 604.

JIWUBA, P. D., OKORONKWO, M. O. and OKECHUKWU, S. O. (2019).Economics of pig production in Ezza North Local Government Area of Ebonyi State, Nigeria. *Asian Journal of Agricultural Extension, Economics and Sociology*, 29(1): 1 – 11.

JUFARE, A., AWOL, N., TADESSE, F., TSEGAYE, Y. and HADUSH, B. (2015). Parasites of pigs in two farms with poor husbandry practices in Bishaftu, Ethiopia. *Onderstepoort Journal of Veterinary Research,* 82(1): 839 – 843.

KAKIHARA, D., YOSHIMITSU, K., ISHIGAMI, K., IRIE, H., AIBE, H., TAJIMA, T., SHINOZAKI, K., NISHIE, A., NAKAYAMA, T., HAYASHIDA, K. and NAKAMUTA, M. (2004).Liver lesions of visceral larva migrans due to *Ascaris suum* infection. *Abdominal Imaging*, 29(5): 598 – 602.

MAGANGA, G.D., KOMBILA, L.B., BOUNDENGA, L., KINGA, I.C.M., OBAME-NKOGHE, J., TCHOFFO, H., GBATI, O.B. and AWAH-NDUKUM, J. (2019). Diversity and prevalence of gastrointestinal parasites in farmed pigs in South East Garbon, Central Africa. *Veterinary World*, 12(12): 1888 – 1896.

NWAFOR, I., ROBERTS, H. and FOURIE, P. (2019). Prevalence of gastrointestinal helminths and parasites in small-holder pigs reared in the central Free State Province. *Onderstepoort Journal of Veterinary Research*, 86(1): 1 – 8.

OLSON, M. E. and GUSELLE, N. (2000). Are pig parasites a human health risk. *Advances in Pork Production*, 11: 153 – 162.

OTTE, J., COSTALES, A., DIJKMAN, J., PICA-CIAMARRA, U., ROBINSON, T., AHUJA, V., LY, C. and ROLAND-HOLST, D. (2012). *Livestock Sector Development for Poverty Reduction: An Economic and Policy Perspective. Livestock's Many Virtues*. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy. https://www.fao.org/3/;2744e/i2744e00.pdf

PARK, K. (2009). *Parks Textbook of Preventive and Social Medicine*. 20th Edition, M/S

Banarsidas Bhanot Publishers, Jabalpur, India.

SAKAKIBARA, A., BABA, K., NIWA, S., YAGI, T., WAKAYAMA, H., YOSHIDA, K., KOBAYASHI, T., YOKOI, T., HARA, K., ITOH, M. and KIMURA, E. (2002). Visceral larva migrans due to *Ascaris suum* which presented with eosinophilic pneumonia and multiple intra-hepatic lesions with severe eosinophil infiltration-outbreak in a Japanese area other than Kyushu. *Internal Medicine*, 41(7): 574 – 579.

SINGH, A. K., DAS, G., NATH, S., KUMAR, S., NARESH, R. and AGRAWAL, V. (2017). Prevalence of gastrointestinal parasitic infections in pig in and around Jabalpur, Madhya Pradesh, India. *Indian Veterinary Journal,* 94(3):17 – 19.

SOULSBY, E. J. L. (1982). *Helminths, Arthropods and Protozoa of Domesticated Animals*. Seventh Edition, Baillière Tindall, London.

SOWEMIMO, O. A., ASAOLU, S. O., ADEGOKE, F. O. and AYANNIYI, O. O. (2012). Epidemiological survey of gastrointestinal parasites of pigs in Ibadan, Southwest 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. and DEMBELE, M. A. (2006). Prevalence of common gastrointestinal nematode parasites in scavenging pigs of different ages and sexes in Eastern Centre Province, Burkina Faso. *Onderstepoort Journal of Veterinary Research*, 73(1): 53 – 60.

TIWARI, K. P., CHIKWETO, A., BELOT, G., VANPEE, G., DEALLIE, C., STRATTON, G. and SHARMA, R. N. (2009). Prevalence of intestinal parasites in pigs in Grenada, West Indies. *West Indian Veterinary Journal*, 9(1): 22 – 27.

USUWA, I. S., AKPA, C. O., UMEOKONKWO, C. D., UMOKE, M., OGUANUO, C. S., OLORUKOOBA, A. A., BAMGBOYE, E. and BALOGUN, M. S. (2020). Knowledge and risks perception towards Lassa fever infection among residents of affected communities in Ebonyi State, Nigeria: implications for risk communication. *BMC Public Health*, 20: 217. https://doi.org/10.1186/s12889-02 0-8299-3

WALL, R. and SHEARER, D. (2001). *Veterinary Ectoparasites: Biology, Pathology and Control.* Second Edition, Blackwell Science Limited, London.

WIKIPEDIA (2021). *Pig Farming*. Wikipedia.org. https://en.wikipedia.org/wiki/Pig_farming