Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(2): 1185-1189

Received: 12-01-2019
Accepted: 15-02-2019

M Das
Senior Scientist, Division of Animal Health, ICAR Research Complex for NEH Region, Umiam, Meghalaya, India

R Laha
Principal Scientist, Division of Animal Health, ICAR Research Complex for NEH Region, Umiam, Meghalaya, India

G Khargharia
Chief Technical Officer (T7), Division of Livestock Production, ICAR Research Complex for NEH Region, Umiam, Meghalaya, India

A Sen
Principal Scientist, Division of Animal Health, ICAR Research Complex for NEH Region, Umiam, Meghalaya, India

Correspondence
M Das
Senior Scientist, Division of Animal Health, ICAR Research Complex for NEH Region, Umiam, Meghalaya, India

Coccidiosis in pigs of subtropical hilly region of Meghalaya, India

M Das, R Laha, G Khargharia and A Sen

Abstract
To determine the prevalence of coccidia infections in pigs of subtropical hilly region of Meghalaya, a total of 2574 Fecal samples of pigs from different age groups <6 months (706 nos.), 6-12 months (896 nos.) and >12 months (972 nos.) were collected and screened by flotation techniques. Oocysts of *Cryptosporidium* spp. were examined by Sheather's sucrose flotation, Malachite green staining (0.2%) and modified Ziehl-Neelsen staining techniques. The overall prevalence of coccidia infections in pigs of Meghalaya was 16.86%. Three different species of coccidia were observed, *Eimeria* spp. (11.50%), *Isospora suis* (2.45%) and *Cryptosporidium* spp. (2.91%). Age wise, 26.35%, 15.74%, and 11% infections were recorded in <6 months, 6-12 months and >12 months old pigs, respectively. Highest and lowest infections was recorded in the month of August (32.83%) and January (6.93%), respectively. Season wise infection was recorded highest during rainy season (21.95%) followed by cool (18.16%), hot (12.35%) and cold (10.07%) season. Six species of *Eimeria* were recorded *viz. E. debliecki* (42.23%), *E. porci* (13.85%), *E. suis* (27.36%), *E. perminuta* (12.5%), *E. cerdonis* (1.69%) and *E. spinosa* (2.36%). The oocyst count per gram of feces ranged from 502.87-1826.64 in infected pigs.

Keywords: Pigs, coccidia, species, Meghalaya

Introduction

Animal husbandry is an important subsector of agriculture and pig rearing is one of the important livestock components of the tribal population of Meghalaya. It is a major source of income for the landless and marginal farmers which directly influence their socio-economic status. The consumption of pork is increasing due to per capita income, urbanization, changes in life style and food habit [39]. So, the tribal population of this region may increase their income through pig rearing. But one of the major constraints in pig rearing is the gastrointestinal (GI) parasitic infections [21]. Coccidiosis is one of the most pathogenic GI parasitic diseases caused by the different species of Phylum-Apicomplexa [1]. It is a common problem of confined animals kept under intensive husbandry practices. The disease is characterized by scours, dehydration, rough hair coat, reduced growth rate, weakness, weight loss, variable mortality and morbidity and is not responsive to most antibacterial therapy. It is caused by small parasites that multiply inside the host cell mainly in the intestinal tract *viz. Eimeria* spp., *Isospora suis* and *Cryptosporidium* spp. [33]. Coccidiosis is more common and wide spread in suckling piglets but is seen occasionally in growing and finishing pigs and boars when they are moved or housed into continually populated and infected pens [36]. It is suspected in young pigs suffering from continuous diarrhoea which does not respond to antibiotic therapy. In early stage, diarrhoea is the main clinical signs and in later stage consistency of feces varies and colour varies from yellow to grey green or bloody according to the severity of the condition. According to Davies *et al*. [10] and Ruprah [31] oocysts of coccidia are passed in feces and may not cause a significant mortality but can certainly cause a clinical disease or can at least retard the growth of pigs. Environmental factors play a pivotal role in the dissemination and prevalence of coccidia infections in susceptible animals. It is mostly transmitted by ingestion of contaminated feed and water with oocysts of coccidia. Although several authors studied the prevalence of GI parasitic infections in pigs of Meghalaya [21, 22, 43, 6] but detailed reports on the prevalence of different species of coccidia have not been mentioned. In piglets, coccidiosis causes poor performance during the fattening period as well as diarrhoea, and also predisposes the animal to secondary bacterial and viral infections [20, 25]. This is mainly due to disruption of small intestine villi and surface area which interrupts with normal absorption process of nutrients. Therefore, taking into account the significance of the

coccidia parasites as one of the most important causes of economic losses in pigs, the present study was designed to determine the prevalence of different species of coccidia in pigs of hilly region of Meghalaya.

2. Materials and Methods

2.1 Study area

The present study was conducted in three districts of Meghalaya, *viz.*, Ri Bhoi, East Khasi Hills and Jaintia Hills. Ri Bhoi district occupies an area of 2378 km^2 and lies between 25°15´ and26°15´ North latitudes and 91°45´ and 92°15´ East longitudes. (https://en.wikipedia.org/wiki/Ri-Bhoi_district). East Khasi Hills district forms a central part of Meghalaya and covers a total geographical area of 2748 km^2. It lies between 25°07´ and 25°41´ North latitudes and 91°21´ and 92°09´ East longitudes. (https://en.wikipedia.org/wiki/East_Khasi_Hills_ district). Jaintia Hills district is the eastern most part of the Meghalaya with a geographical area of 3819 Km^2. It lies between 20°58′ and 26°3′ North latitudes and 91°59′ and 92°51′ East longitudes. (http://westjaintiahills.gov.in/MapAnthem.htm). The study area was situated at an altitude of about 400-1800m above mean sea level where average monthly minimum and maximum temperature were 6.5°C and 30.8°C, respectively. The average monthly relative humidity prevailed during the study period was 61.6% (minimum) to 88.9% (maximum) with average annual total rainfall 2891 mm.

2.2 Study period

The study was conducted for two years (2015-16, 2016-17) and divided into four seasons, *viz.*, hot (March, April), rainy (May, June, July, August, September), cool (October, November) and cold (December, January, February).

2.3 Sample size

A total of 2574 fecal samples of pigs were collected from both organized and unorganized farms present in three districts of Meghalaya and screened for detection of coccidia infections.

2.4 Study method

The selected animals were categorized according to age *viz.* <6 months, 6-12 months and >12 months. Fecal samples were collected directly from the rectum of the individual animal and kept in marked plastic pouch/vials. Three grams of fecal samples were examined by direct flotation technique using saturated salt (specific gravity: 1.20) and sucrose (specific gravity: 1.27) solution [27]. Samples found positive for *Eimeria* spp. and *Isospora suis* were then quantified to estimate the oocysts per gram (OPG) of feces by using modified McMaster technique [33]. Samples not being examined on the same day were preserved in 2.5% potassium dichromate solution and stored at refrigerated temperature (4°C) for next day examination. Sporulation of the oocyst was done by mixing positive fecal sample containing oocyst of *Eimeria* spp. and *Isospora suis* with 2.5% potassium dichromate solution in a ratio of 1:5 volume as per the standard procedure [27, 32]. Morphological characterization of the oocysts was done as per the guidelines of Daugschies *et al.* [9] and Soulsby [33] by using an Olympus BX51 light microscope at 200x and 400x magnifications. For detection of *Cryptosporidium* spp. in fecal samples of pigs, fecal samples were examined at first by Sheather's sucrose flotation method for concentration of *Cryptosporidium* oocysts as per the procedure described by Barr [4]. Malachite green staining technique was also used for the detection of *Cryptosporidium* spp. as per the method described by Elliot *et al.* [11] with slight modifications. A drop of fecal sediment and a drop of malachite green stain (0.2%) were mixed on a glass slide, evenly spread and air dried and examined under magnification (400x) and oil immersion (1000x). The positive sample was then subjected to modified Ziehl-Neelsen staining technique [15] and examined under microscope (400x, 1000x) for detection of *Cryptosporidium* oocysts.

3. Results and Discussion

The overall prevalence of coccidiosis in pig of hilly region of Meghalaya was 16.86%. Three different species of coccidia were observed under Phylum-Apicomplexa in the present study *viz. Eimeria* spp. (11.50%), *Isospora suis* (2.45%) and *Cryptosporidium* spp. (2.91%) (Table 1). In the present findings, it has been observed that the prevalence of different species of coccidia infection followed an age pattern. Age wise, 26.35%, 15.74%, and 11% infections were recorded in <6 months, 6-12 months and >12 months pigs, respectively. The prevalence of *Eimeria* spp. was highest in 6-12 months (13.06%), followed by <6 months (11.47%) and >12 months (10.08%). However, *I. suis* was recorded highest in <6 months (4.25%), followed by 6-12 months (2.68%) and >12 months (0.93%). *Cryptosporidium* spp. was recorded only in <6 months (10.62%) old pigs (Fig. 1). District wise highest prevalence of coccidiosis was recorded in Ri Bhoi (21.25%) followed by East Khasi Hills (15.02%) and Jaintia Hills (12.62%) (Fig. 2). Month wise highest and lowest infections was recorded in the month of August (32.83%) and January (6.93%), respectively (Fig. 3). Maximum and minimum OPG was recorded in the month of July (425.17) and February (122.22), respectively. Season wise infection was recorded highest during rainy season (21.95%) followed by cool (18.16%), hot (12.35%) and cold (10.07%) season (Table 2). The OPG of feces ranged from 502.87-1826.64 in infected pig. In the present study, variations in the percent prevalence of different species of *Eimeria* spp. were observed according to age. Six species of *Eimeria* were recorded *viz. E. debliecki* (42.23%), *E. porci* (13.85%), *E. suis* (27.36%), *E. perminuta* (12.5%), *E. cerdonis* (1.69%) and *E. spinosa* (2.36%) (Table 3). All the species of *Eimeria* were identified on the basis of their morphological characters (Fig. 4) for the first time from the hilly region of Meghalaya. In <6 months old pigs, *E. porci* (34.15%) was highest followed by *E. suis* (33.33%), *E. debliecki* (30.4%) and *E. perminuta* (27.02%). However, in 6-12 months old pigs, *E. perminuta* (51.35%) were recorded highest followed by *E. debliecki* (49.6%), *E. suis* (41.98%), *E. porci* (41.46%), *E. spinosa* (2.36%) and *E. cerdonis* (1.69%). In >12 months old pigs, *E. suis* (24.69%) was highest followed by *E. porci* (24.39%), *E. perminuta* (21.62%) and *E. debliecki* (20%).

The present study revealed prevalence of 16.86% coccidia infections in pigs of hilly region of Meghalaya which was in accordance with the findings of Kaur *et al.* [17] from Punjab and Krishnamurthy *et al.* [18] from Karnataka. Similarly, prevalence of coccidiosis in pigs from different parts of the world are reported by Roesel *et al.* [30] from Uganda (40.7%), Jufare *et al.* [16] from Ethiopia (12%), Geresu *et al.* [12] from Ethiopia (11.8%), Abdu and Gashaw [2] from Ethiopia (5.6%), Matsubayashi *et al.* [26] from Japan (40.3%), Tiwari *et al.* [38] from West Indies (88%), Weka and Ikeh [40] from Nigeria (15.6%) and Weng *et al.* [41] from China (47.2%). The

variation in the prevalence from the present study may be attributed due to different geographical distributions, host factors, climatic conditions required for their development [7] as well as management practices adopted in different regions. In the present study it was observed that the percentage of coccidia infections in young animals (<6 months, 6-12 months) were highest and maximum during the month of August. Similar reports on the maximum prevalence of coccidiosis were reported by Tsunda *et al.* [36]. This may be due to immature immunity in younger animals and continuous dissemination of infection in the environment by adult carrier animals which make young animals more susceptible towards infection. The OPG of feces ranged from 502.87-1826.64 in infected pig which was in agreement with the findings of Chhabra and Mafukidze [5].

Reports on the prevalence of different species of coccidia in pigs of India are extremely meagre. The first report was of Ahluwalia [3] from Uttar Pradesh followed by Gill [13] from Izatnagar, Patnaik [29] from Orissa, Mishra [28] from Uttar Pradesh, Shrivastav and Shah [34] from Madhya Pradesh and Tayo *et al.* [37] from Arunachal Pradesh. In the present study, different species of coccidia (*Eimeria* spp., *Isospora suis*, *Cryptosporidium* spp.) were identified which was in conformity with the findings from Azerbaijan [14], China [24] and Poland [19]. In the present study, six different species of *Eimeria* spp. were identified. In contradiction to our findings, Tsunda *et al.* [36] from Nigeria and Daugschies *et al.* [8] from Germany reported prevalence of different species of *Eimeria* in pigs *viz. E. perminuta*, *E. scabra*, *E. spinosa*, *E. debliecki*, *E. polita*, *E. suis* and *E. porci*. Leyton *et al.* [23] from Ontario, Canada reported high rate of *Isospora suis* (26.4%) infections in suckling pigs. Tomass *et al*. [35] and Yin *et al.* [42] from Ethiopia and China reported 7% and 17% *Cryptosporidium* spp. in pigs, respectively. As far as our knowledge is concerned there are no reports on the prevalence of different *Eimeria* spp. and *Cryptosporidium* spp. in pigs of Meghalaya and this report on the prevalence of six species i.e. *E. debliecki*, *E. porci*, *E. suis*, *E. perminuta*, *E. cerdonis*, *E. spinosa* and *Cryptosporidium* spp. may be considered as the first report from Meghalaya.

The present study revealed that coccidia infections in pigs are common and prevalent throughout the year in Meghalaya which was in agreement with the findings of Tsunda *et al.* [36]. This might be due to favorable environmental conditions for propagation and perpetuation of the parasites and non-administration of coccidiostat or coccidicidal drugs by the farmers. Other factors which might be responsible are constant exposure to infections, continuous deposit of infections by the adult carrier animals as well as poor animal husbandry practices.

Table 1: Age wise prevalence of coccidiosis in pigs of Meghalaya

Age (months)	Sample examined	Sample positive	Apicomplexa		
			***Eimeria* spp.**	***Isospora suis***	***Cryptosporidium* spp.**
<6	706	186 (26.35)	81 (11.47)	30 (4.25)	75 (10.62)
6-12	896	141 (15.74)	117 (13.06)	24 (2.68)	---
>12	972	107 (11)	98 (10.08)	9 (0.93)	---
Total	2574	434 (16.86)	296 (11.50)	63 (2.45)	75 (2.91)

Figures in parentheses indicates percent positivity

Table 2: Season wise prevalence of coccidiosis in pigs of Meghalaya

Season	Sample examined	Sample positive	Apicomplexa			OPG
			***Eimeria* spp.**	***Isospora suis***	***Cryptosporidium* spp.**	
Hot (Mar, Apr)	421	52 (12.35)	40 (9.50)	2 (0.48)	10 (2.38)	429.98
Rainy (May, Jun, Jul, Aug, Sep)	1034	227 (21.95)	147 (14.22)	37 (3.58)	43 (4.16)	1826.64
Cool (Oct, Nov)	523	95 (18.16)	69 (13.19)	14 (2.68)	12 (2.29)	686.81
Cold (Dec, Jan, Feb)	596	60 (10.07)	40 (6.71)	10 (1.68)	10 (1.68)	502.87

Table 3: Prevalence of different species of *Eimeria* in pigs of Meghalaya

***Eimeria* spp.**	**<6 months**	**6-12 months**	**>12 months**	**Total**
E. debliecki	38 (30.4)	62 (49.6)	25 (20)	125 (42.23)
E. porci	14 (34.15)	17 (41.46)	10 (24.39)	41 (13.85)
E. suis	27 (33.33)	34 (41.98)	20 (24.69)	81 (27.36)
E. perminuta	10 (27.02)	19 (51.35)	8 (21.62)	37 (12.5)
E. cerdonis	-	5 (1.69)	-	5 (1.69)
E. spinosa	-	7 (2.36)	-	7 (2.36)

a. Sheather's sugar flotation (1000x)	b. Malachite green stain (0.2%) (1000x)	c. Modified Ziehl Neelsen stain (1000x)

Fig 1: Oocysts of *Cryptosporidium* spp. in pigs

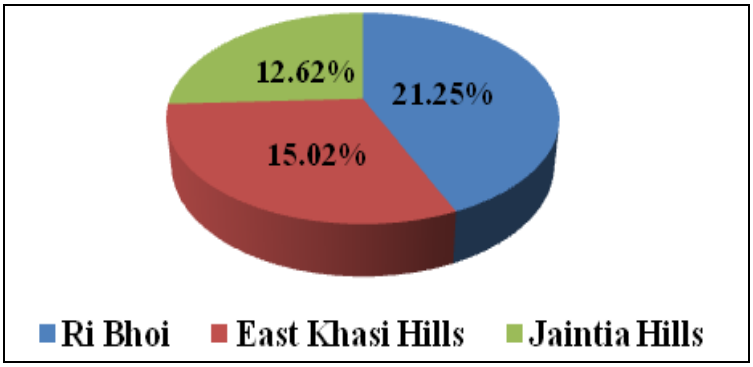

Fig 2: District wise prevalence of coccidiosis in pigs of Meghalaya

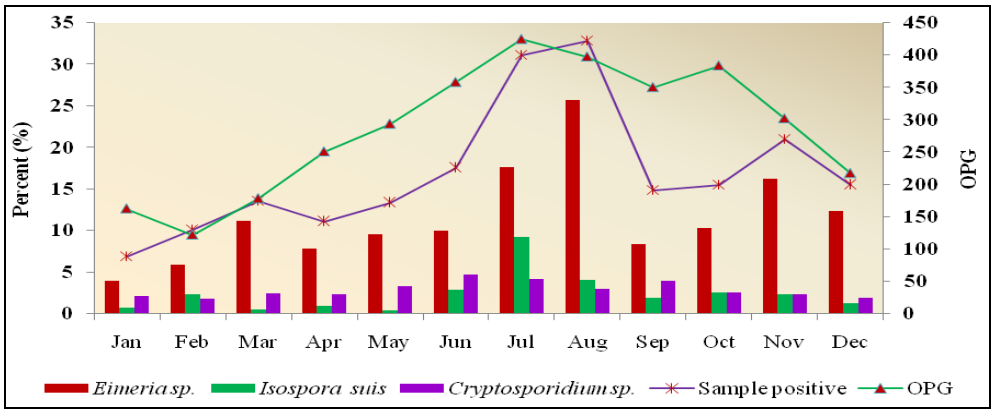

Fig 3: Month wise prevalence of different species of Coccidia in pigs of Meghalaya

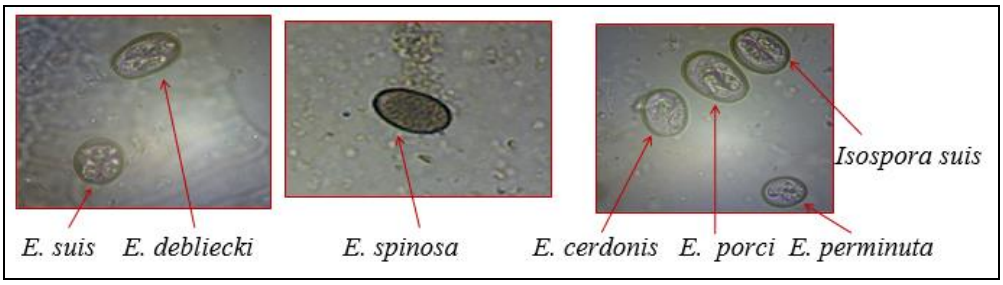

Fig 4: Different species of *Eimeria* in pigs of Meghalaya

4. Conclusion

The present study revealed prevalence of three types of coccidia i.e. *Eimeria* spp., *Isospora suis* and *Cryptosporidium* spp. in pigs of Meghalaya and mostly prevalent during rainy season. Young animals are mostly susceptible. Six species of *Eimeria* spp. were also observed in pigs throughout the year.

5. Acknowledgement

We are thankful to the Director, ICAR Research Complex for NEH Region, Umiam, Meghalaya for providing financial assistance and other facilities to carry out this research work under the project 'Protozoan parasitic infections of swine in Meghalaya' (Institute Code-IXX12330).

6. References

1. Almeida VDA, Magalhaes VCS, Muniz-Neta ES, Munhoz AD. Frequency of species of the genus *Eimeria* in naturally infected cattle in Southern Bahia, Northeast Brazil. Brazilian Journal of Veterinary Parasitology. 2011; 20:78-81.
2. Abdu S, Gashaw A. Production system dynamism and parasitic interaction of swine in and around Holetta, Ethiopia. Ethiopian Veterinary Journal. 2010; 14:71-81.
3. Ahluwalia SS. A survey of helminth parasites of the domestic pigs in Western Uttar Pradesh with a note on *Pseudanaplocephala crawfordi* Baylis. Indian Journal of Veterinary Science. 1959; 29:100-107.
4. Barr SC. Cryptosporidiosis in Infectious Diseases of the Dog and Cat. 2nd Edn., W.B. Saunders Company, Philadelphia, 1998.
5. Chhabra RC, Mafukidze RT. Prevalence of coccidia in pigs in Zimbabwe. Veterinary Parasitology. 1992; 41(1-2):1-5.
6. Chandra D, Ghosh SS. Distribution of gastrointestinal nematodes in pigs in Meghalaya. Indian Journal of Hill Farming. 1989; 2:65-68.
7. Das M, Deka DK, Sarmah PC, Islam S, Sarma S. Diversity of *Eimeria* spp. in dairy cattle of Guwahati, Assam, India. Veterinary World. 2015; 8(8):941-945.
8. Daugschies A, Imarom S, Ganter M, Bollwahn W. Prevalence of *Eimeria* spp. in Sows at Piglet-producing Farms in Germany. Journal of Veterinary Medicine. 2004; 51(3):135-139.
9. Daugschies A, Imarom S, Bollwahn W. Differentiation of porcine *Eimeria* spp. by morphologic algorithms. Veterinary Parasitology. 1999; 81:201-210.
10. Davies SFM, Joyner LP, Kendall SB. Coccidiosis. Oliver and Boyd, Edinburgh, 1963, 264.

11. Elliot A, Morgan UM, Thompson RCA. Improved staining method for detecting *Cryptosporidium* oocysts in stools using malachite green. The Journal of General and Applied Microbiology. 1999; 45(3):139-142.
12. Geresu MA, Hailemariam Z, Mamo G, Tafa M, Megersa M. Prevalence and Associated Risk Factors of Major Gastrointestinal Parasites of Pig Slaughtered at Addis Ababa Abattoirs Enterprise, Ethiopia. Journal of Veterinary Science and Technology. 2015; 6(4):244.
13. Gill BS. The coccidian oocysts of Indian pigs. Proceedings of the Indian Science Congress. 1990, 430.
14. Hajiyeva N, Ali G, Ahmadov E, Ilyas O. Intestinal parasites in domestic pigs (Sus scrofa *domesticus*) in farms of Azerbaijan. Journal of Entomology and Zoology Studies. 2016; 4(3):170-173.
15. Henriksen SA, Pohlenz JFL. Staining of cryptosporidium by modified Ziehl-Neelsen technique. Acta Veterinaria Scandinavica. 1981; 22:594-596.
16. Jufare A, Awol N, Tadesse F, Tsegaye Y, Hadush B. Parasites of pigs in two farms with poor husbandry practices in Bishoftu, Ethiopia. Onderstepoort Journal of Veterinary Research, 2015, 82(1). doi.org/10.4102/ojvr.v82i1.839.
17. Kaur M, Singh BB, Sharma R, Gill JPS. Prevalence of gastrointestinal parasites in pigs in Punjab, India. Journal of Parasitic Disease. 2017; 41(2):483-486.
18. Krishnamurthy CM, Ananda KJ, Adeppa J, Satheesha M. Studies on gastrointestinal parasites of pigs in Shimoga region of Karnataka. Journal of Parasitic Disease. 2016; 40(3):885-889.
19. Karamon J, Ziomko I, Cencek T. Prevalence of *Isospora suis* and *Eimeria* spp. in suckling piglets and sows in Poland. Veterinary Parasitology. 2007; 147:171-175.
20. Koudela B, Vitovec J. Biology and pathogenicity of *Eimeria neodebliecki* Vetterling, 1965 in experimentally infected pigs. Parasitology International. 1998; 47(4):249-256.
21. Laha R, Das M, Goswami A, Sailo B, Sharma BK, Gangmei D *et al*. Prevalence of gastrointestinal parasitic infections in pigs of North Eastern Region of India. Indian Journal of Hill Farming. 2014a; 27(1):110-117.
22. Laha R, Das M, Goswami A, Sen A, Kumar S, Kadirvel G. Epidemiology of gastrointestinal parasitism in pigs in subtropical Hill Zone of Meghalaya. Indian Journal of Hill Farming. 2014b; 27(1):59-63.
23. Leyton AA, Webster E, Friendship R, Dewey C, Vilaça K, Peregrine AS. An observational study on the prevalence and impact of *Isospora suis* in suckling piglets in south western Ontario, and risk factors for shedding oocysts. Canadian Veterinary Journal. 2011; 52:184-188.
24. Lai M, Zhou RQ, Huang HC, Hu SJ. Prevalence and risk factors associated with intestinal parasites in pigs in Chongqing, China. Research in Veterinary Science. 2011; 91(3):e121-4. doi: 10.1016/j.rvsc.2011.01.025.
25. Lindsay DS, Blagburn BL, Powe TA. Enteric coccidial infections and coccidiosis in swine. Compendium on Continuing Education for the Practising Veterinarian. 1992; 14:698-702.
26. Matsubayashi M, Kita T, Narushima T, Kimata I, Tani H, Sasai K *et al*. Coprological Survey of Parasitic Infections in Pigs and Cattle in Slaughterhouse in Osaka, Japan. Veterinary Medicine and Science. 2009; 71(8):1079-1083.
27. MAFF. Ministry of Agriculture, Fisheries and Food. Manual of veterinary parasitological techniques, Her Majesty's Stationery Office, London, 1986.
28. Mishra GS, Pande BP. Helminthic infections of piglets with reference to lesions encountered. Indian Journal of Veterinary Science. 1963; 37:143-149.
29. Patnaik MM. Helminth parasites of domestic animals in Orissa. Orissa Veterinary Journal. 1963; 1:94-102.
30. Roesel K, Dohoo I, Baumann M, Dione M, Grace D, Clausen PH. Prevalence and risk factors for gastrointestinal parasites in small-scale pig enterprises in Central and Eastern Uganda. Parasitology Research. 2017; 116:335-345.
31. Ruprah NS. Atattriok of clinical Protozoology. Oxonnian press PVT. Ltd. New Delhi, 1985.
32. Sloss MW, Kemp RL, Zajac AM. Veterinary Clinical Parasitology. 6th ed. Iowa State University Press, Ames, Iowa, 1994.
33. Soulsby EJL. Helminths, Arthropods and Protozoa of Domestic Animals. 7th ed. Bailliere, Tindall and Cassell, London, 1982.
34. Shrivastava HOP, Shah HL. Coccidia of pigs in Madhya Pradesh, with description of the sporulated oocysts of seven species. Indian Veterinary Journal. 1968; 45:204-211.
35. Tomass Z, Imam E, Kifleyohannes T, Tekle Y, Weldu K. Prevalence of gastrointestinal parasites and *Cryptosporidium* spp. in extensively managed pigs in Mekelle and urban areas of southern zone of Tigray region, Northern Ethiopia. Veterinary World. 2013; 6(7):433-439.
36. Tsunda BM, Ijasini SB, Jamala GY. Porcine Coccidiosis: Prevalence Study in Ganye Southeasthern Admawa State, Nigeria. IOSR Journal of Agriculture and Veterinary Science. 2013; 6(2):44-46.
37. Tayo T, Longjam N, Perme B. Protozoan Diseases of Livestock in Arunachal Pradesh - An Overview. Veterinary World. 2011; 4(7):332-336.
38. Tiwari KP, Chikweto A, Belot G, Vanpee G, Deallie C, Stratton G *et al*. Prevalence of intestinal parasites in pigs in Grenada, West Indies. West Indian Veterinary Journal. 2009; 9:22-27.
39. Wright IA, Deka R, Thorpe W, Lapar ML. The pig sector in North East India: status, constraints and opportunities. International Symposium 'Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia', Hanoi, 2010. http://cgspace.cgiar.org/bitstream/handle/10568/2233/175.pdf?sequence=2. 2010.
40. Weka RP, Ikeh EI. Seroprevalence of cysticercosis and intestinal parasitism in pigs in Jos metropolis. Journal of Animal and Veterinary Advances. 2009; 8:883-887.
41. Weng YB, Hu YJ, Li Y, Li BS, Lin RQ, Xie DH *et al.* Survey of intestinal parasites in pigs from intensive farms in Guangdong province, People's Republic of China. Veterinary Parasitology. 2005; 127:333-336.
42. Yin J, Shen Y, Yuan Z, Lu W, Xu Y, Cao J. Prevalence of the *Cryptosporidium* Pig Genotype II in pigs from the Yangtze river delta china. PloS ONE. 2011; 6(6):e20738.
43. Yadav AK, Tandon V. Nematode parasite infections of domestic pigs in sub-tropical and high rainfall area of India. Veterinary Parasitology. 1989; 31:133-139.