STUDIES ON PREVALENCE OF GASTROINTESTINAL PARASITES OF PIGS

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CERTIFICATE

This is to certify that the thesis entitle **"*STUDIES ON PREVALENCE OF GASTROINTESTINAL PARASITES OF PIGS"*** submitted by **Ms. CHAITRA K. GOWDA, I.D. No. MVHK- 1350** in partial fulfillment of the requirement for the award of **MASTER OF VETERINARY SCIENCE** in **VETERINARY PARASITOLOGY** of the **Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar** is a record of bonafide research work carried out by her during the period of her study in this University under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma, associateship fellowship or other similar titles.

Bangalore
July, 2015

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Affectionately Dedicated to

My Beloved Parents, Sister and

Brother

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LIST OF ABBREVATIONS / ACRONYMS

%	per cent
µm	micrometer
ANOVA	Analysis of Variance
BBMP	Bruhat Bangalore Mahanagara Palike
C^o	degree centigrade
cm	centimeter
EPG	Eggs per gram
Fig	Figure
g	gram
GIT	Gastrointestinal tract
GKVK	Gandhi Krishi Vignan Kendra
Govt.	government
hrs	hours
IAH & VB	Institute of Animal health & Veterinary Biological
ILFC	Instructional livestock farm complex
mg	milligram
min	minutes
ml	millilitre
mm	millimeter
MNZ	Modified Ziehl-Neelsen
NaCl	Sodium chloride
No.	Number
OPG	oocysts per gram

rpm	rotation per minute
sec	seconds
sp.	species
yrs	years
et al	*et alia*

Introduction

I. INTRODUCTION

Pig farming in India has a special significance and tremendous scope for improving the socio economic status of the weaker section of society. It is a gainful subsidiary occupation and provides a relief from the economic crisis of marginal farmers. Pig rearing and pork consumption are popular in north eastern states, Bihar and certain pockets of India like Goa, Madhya Pradesh, Karnataka and Andhra Pradesh. In Karnataka pigs are mainly reared in the free range system by socio-economically backward people. Pigs are reared either in confinement or in a semi confined manner in farms or backyards of houses. Pork consumption is maximum among people in Hassan, Kodagu and Dakshina Kannada districts when compared with other districts of Karnataka and is also widely marketed in urban and rural areas. In Bangalore except for regulated slaughter at the BBMP slaughter house, pigs are slaughtered in slums and in other places and the meat is sold in markets or in temporary stalls on the roadside. The pig population in Karnataka is 3,04,798 (18^{th} census 2007 by Joint director of Statistic department of A.H & V.S, Govt. of Karnataka) where as in India, the population is 96,30,000 (FAO, 2012).

Pork production in India is limited, representing only 7% of the country's animal protein sources. The present production of pork in India is estimated at 6.27 million tons/year in 2010 (FAO, 2012), which is 2.21% of the world's meat production and the pork production in Karnataka was 12,000 metric tons/year (Department of Animal Husbandry, Dairy and Fisheries 2009-10). In recent years, the swine industry is improving with introduction of cross-bred pigs, increases in consumption of pork is due to urbanization, change in life style and change in food habits.

Among the swine diseases gastrointestinal parasites are responsible for substantial loss of productivity and economic losses in swine industry. Gastrointestinal parasitism in swine affects their performance in terms of poor growth rate, reduced weight gain, decreased litter size, poor feed utilization and conversion, reduced fertility, and condemnation of organs after slaughter (Nsoso *et al.*, 2000) especially liver affected with milk spot caused by *A. suum* and nodule formation in intestine due to *Oesophagostomum spp*. apart from bladder worm infected meat and organ. In India both indigenous and cross breed pigs are reared on free rage system and under confinement respectively. These free range pigs are primarily scavengers utilizing food scraps thrown away by people and they thrive on low planes of nutrition. Scavenging by pigs favours the uptake of infective parasitic stages made them susceptible to infection. Moreover, the warm and humid conditions of the tropics and inadequate treatment of local pigs with anthelmintics is yet another cause for heavy burdens of gastrointestinal parasites.

Pigs also harbour a range of gastrointestinal parasites and diseases that can be transmitted to humans. These include *F. buski* infection, Balantidiosis, Ascariosis and Cryptosporidiosis.

Thirty-nine percent (39.0%) of children have been found to be infected with *Fasciolopsis buski* in India and Bangladesh (Dey *et al.*, 2014). Prevalence of *F. buski* was 60.0 per cent from non-described pigs in Assam, Bihar, Uttar Pradesh, Madhya Pradesh and Tamil Nadu. In Assam alone 33 per cent of pigs were found infected with *F. buski* (Sarma & Gogoi 1986).

Balantidium coli exists as a commensal in small intestine of pigs. Man may occasionally become infected through contamination of feed and water. Transmission occurs by ingestion of cysts. However, incidence is higher in communities that live in close association with pigs. Some cases of *B. coli* infection in immunocompromised patients, including HIV/AIDS patients, patients with malignancies and transplantation recipients have been reported (Yazar *et al.,* 2004). There are few recorded cases of patent *A. suum* infection in man but cross-infection is not of epidemiological significance.

The prevalence of gastrointestinal parasites in pigs from the North-Eastern region has been studied by different authors (Endrejat, 1964; Sarma and Gogoi, 1986; Yadav and Tandon, 1989). However, the data available on prevalence of gastrointestinal parasites in pigs in Karnataka is spare and a very few reports are available on (D'Souza *et al.*, 2001; Murthy *et al.*, 2014).

Considering the importance of parasites which influence the health and production of pigs as well as its zoonotic importance, since there is a need to carry out a systemic study of gastrointestinal parasites of pigs, hence the present work on "Studies on Prevalence of gastrointestinal parasites of pigs" was undertaken with the following objectives.

- To study the prevalence of gastrointestinal parasites of Pigs in farm and free range pigs.
- To observe for the parasites of zoonotic importance.

Review of Literature

II. REVIEW OF LITERATURE

2.1. Prevalence of GI parasites in India

Rao (1935) recorded *Fasciolopsis buski* and *Echinostoma spp.* from small intestine of pigs from Bengal.

Ramanujachari and Alwar (1953) reported the occurrence of *Simondsia paradoxa* for the first time in India.

Thapar (1956) reported the occurrence of *Pseudoanoplocephala spp., Fasciolopsis buski, Paramphistomum spp., Ascaris lumbricoides* and *Oesophagostomum dendriticum* in wild boar from Uttar Pradesh.

Rai and Ahluwalia (1958) recorded *Echinostoma spp., Schistosoma spp.* and Spirurid spp. from the intestine and stomach of pigs.

In a slaughter house study conducted in pigs at Madras by Alwar (1958), all the adult pigs were infected with different gastrointestinal parasites like *Paryphostomum sufrartyfex, Schistosoma suis, Pseudoanaplocephala crawfordi, Enterobius vermicularis, Oesophagostomum dentatum, O. brevicaudum, Stephanurus dentatus, Metastrongylus apri, Ascarops strongylina, Physocephalus sexalatus, Simondsia paradoxa, Streptopharagus sp., Onchocerca sp.* and *Trichuris trichiura.*

Singh (1959) examined intestines of 30 pigs slaughtered at the Delhi pig slaughter house. Out of which 15 showed *Ascaris lumbricoides* infection and 9 of them revealed *Macrocanthorhynchus hirudinaceus* infection.

Rao (1966) examined 64 digestive tracts of pigs in Hyderabad, Andhra Pradesh over a period of 3 years. They recorded *Ascarops strongylina, Physocephalus sexalatus, Simondsia paradoxa, Artyfechinostomum sp., Trichuris trichiura, Oesophagostomum sp., Ascaris lumbricoides, Necator sp.* and *Subulura sp.*

Sinha (1968) examined 150 slaughtered pigs and recorded important zoonotic parasites like *Artyfechinostomum sufrartyfex, Opisthorchis noverca, Fasciolopsis buski, Gastrodiscoides hominis, Trichuris trichuria* and *Ascaris lumbricoides var suum.*

Shrivastav and Shah (1968) examined 54 desi pigs slaughtered at Mhow, Indore and Jabalpur, Madhya Pradesh. Three species of trematodes (*Fasciolopsis buski, Opisthorchis caninus, Artyfechinostomum sufrartyfex*), single species of tapeworm (*Pseudoanaplocephala crawfordi*) and 13 species of nematodes (*Ascaris lumbricoides, Enterobius vermicularis, Strongyloides ransomi, Oesophagostomum dentatum, O. brevicaudum, O. longicaudum, Ancylostoma duodenale, Stephanurus dentatus, Metastrongylus apri, Ascarops strongylina, Physocephalus sexalatus, Simondsia paradoxa, Trichuris trichuria*) were recorded.

In Karnataka, Rao and Jagannath (1969) recorded *Metastrongylus salmi* during necropsy of two piglets which died due to pneumonia in Army service corps, Bangalore.

A comparative study between faecal sample and necropsy examination was carried out by Misra *et al.* (1972) which revealed that the infection rate in pigs increased from 64 to 72 per cent for *Ascaris suum,* 63 to 69 per cent for *Oesophagostomum dentatum,* and 46 to 55 per cent for *Trichuris trichuria* respectively. Faecal sample

examination by sucrose flotation technique was found to be more efficient than sodium chloride, sodium nitrate and zinc sulphate solutions.

Out of 142 pigs examined at necropsy in Assam by Sarma and Gogoi (1986), 56.34 per cent of pigs revealed a different species of helminths. The highest incidence of helminths was recorded in the pre-monsoon season (56%) followed by Southwest monsoon (55.81%), post-monsoon (55%) and winter (47.27%). Majority of pigs harboured mixed infection.

Chandra (1984) conducted an epidemiological study in Uttar Pradesh on the occurrence of *Fasciolopsis buski* in human beings and concluded that human beings in close association with pigs who were living near the lake were more prone to infection and found that 29.4 per cent of *F. buski* in the stool specimens of pigs.

A total of 1496 faecal samples of pigs from sub-tropical and high-rainfall areas of India were examined for gastrointestinal parasites by Yadav and Tandon (1989). The species identified were *Ascaris suum, Oesophagostomum dentatum, Bourgelatia diducta, Stephanurus dentatus, Globocephalus connorfilu, Physocephalus sexalutus, Ascarops dentata, A. strongylina, Pseudocruzia orientalis, Setartia bernardi* and *Gnathostoma hispidum. A suum,* was the most prevalent species (51.67%) found in the pigs of that region and of zoonotic importance.

Yadav and Tandon (1991) examined 1496 domestic pigs, from sub-tropical and high-rainfall areas of India. The overall infection rate was considerably higher (76.42 %) in the low-altitude region than in the high-altitude (62.50%).

A total of 960 digestive tracts of pigs were examined from a North-east mountain zone to study the seasonal prevalence of zoonotic trematodes by Roy and Tandon (1992). *Gastrodiscoides hominis*, *Artyfechinostomum malayanum* and *Fasciolopsis buski* were found mostly during the months from June to September whereas *Opisthorchis noverca* was recorded throughout the year except in the month of February.

Deka *et al.* (1995) studied the prevalence of parasites of domestic animals and birds in Lakhimpur (Assam). *Gastrodiscoides hominis, Artyfechinostomum sufrartyfex, Trichuris suis, Strongyloides sp.* were recorded from pigs.

Rajkhowa (1996) reported the incidence of different gastrointestinal parasites of pigs in Meghalaya by screening faecal samples and slaughter house materials, *Ascaris suum* (69.30%) was found to be highest in 0-3 months of age and 8.91 per cent of infection was noticed above 6 months of age group. *Oesophagostomum sp, Trichuris suis, Strongyloides sp, Metastrongylus sp, Macrocanthorhynchus hirudinaceus, Fasciolopsis buski*, oocysts of *Eimeria suis* and *Isospora suis* were identified.

A total of 400 slaughtered pigs were screened at the Bangalore slaughter house by D'Souza *et al.* (2001) for a period of 2 years, out of which 10 per cent of pigs were found infected with *Fasciolopsis buski* flukes.

Coproculture studies were conducted by Kumar *et al*. (2002) in pigs from Ranchi, Jharkhand state and they reported *Ascaris suum, Oesophagostomum dentatum, Trichuris suis, Strongyloides westeri, Necator spp., Ascarops strongylina, Fasciolopsis buski,*

Paragonimus suis, *Schistostoma suis* and trophozoites of *Balantidium coli* from pigs that were reared under organised and traditional systems.

Out of 18 faecal samples from Yorkshire pigs examined by Agrawal *et al*. (2003) from locality of Bhuvaneshwar city, two were positive for *Schistosoma incognitum*.

Agrawal *et al.* (2004) studied the prevalence of helminthic infection in domestic animals in Madhya Pradesh. Out of 32 faecal sample of pigs examined, 6 (18.75%) were found to be infected with *Schistosoma incognitum.*

Deka *et al.* (2005) carried out a systematic survey by faecal examination of pigs, cattle, dogs and goats from north-eastern state of Mizoram. The overall infection of pigs was 23.79 per cent, of which nematode infection accounted for 19.21 per cent and *Ascaris suum* was the predominant species among nematodes. Heavy burden of *Balantidium coli* infection was also recorded.

Dutta *et al*. (2005) recorded the prevalence of the gastrointestinal parasites in pigs of Kolkata and Jalpaiguri districts of West Bengal maintained on backyard and scientific management system. Trematode and nematode infections were high in semi-intensive system of management whereas protozoan infection was maximum on free-range system.

Borthakur *et al*. (2007) studied the prevalence of porcine gastrointestinal parasites in indigenous management systems of Aizawl district of Mizoram. In order to conduct this study, 280 faecal samples and 210 carcasses were examined out of which 37.5 per cent faecal samples were found positive for different helminth ova and 19.52 per cent pig carcasses showed the presence of parasites.

Out of 60 faecal samples of pigs examined by Godara and sharma (2010) in and around Jaipur, 16 (26.66%) were positive for gastrointestinal parasites. The strongyles were predominant (11.66%) followed by *Ascaris* sp. (8.33%), *Strongyloides* sp. (6.66%), *Eimeria* sp. (5.0%), *Balantidium* sp. (3.66%) and *Trichuris* sp. (1.66%).

Khajuria *et al.* (2010) studied the prevalence of gastrointestinal parasites affecting pigs in Jammu. A total of 310 samples were examined and the overall prevalence was 80.64 per cent. Out of which strongyles (35.48%), *Eimeria* oocysts (34.83%), ascarids (30.96%) trematodes (14.83%), *Strongyloides* (10.32%) and *Trichuris spp*. (10.32%) were reported.

Examination of 200 faecal samples and 88 intestinal contents of desi pigs from Patna by Sadarao *et al.* (2011) revealed 55.5 and 46.59 per cent prevalence of *Fasciolopsis buski* respectively. Peak prevalence of infection was recorded during monsoon, post-monsoon and winter months (55-65%). Age-wise prevalence revealed highest (67.39%) infection in pigs over one year of age and lowest (21.87%) in 0-6 months of age. Heavy parasitic burden (56.66-58.90%) was recorded in pigs managed in free range system in comparison with pigs reared under semi-intensive system (25.00-46.29%).

The overall prevalence rate of *Balantidium coli* infection was found to be 93 per cent as recorded by Bauri *et al.* (2012) in pigs from Ranchi, Jharkhand, India.

Ebibeni *et al*. (2013) reported the prevalence of gastrointestinal parasites of backyard pigs in Dimapur district of Nagaland. A total of 117 animals were screened as

per the standard coproscopic methods and the parasites recorded were strongyles followed by *Ascaris suum, Strongyloides ransomi, Ascarops* sp. and *Eimeria* sp.

Maurya *et al*. (2013) screened a total of 938 faecal samples by Modified Ziehl-Neelsen's staining technique from different livestock farms to detect the prevalence of *Cryptosporidium* spp. An overall prevalence of 16.2 per cent of *Cryptosporidium* infection was recorded with prevalence of 19.1 per cent in piglets.

A total of 5511 faecal samples of pigs were examined from four states of North Eastern Region of India from Meghalaya, Manipur, Mizoram and Nagaland, by Laha *et al.* (2014). Overall prevalence of gastrointestinal parasitic infections and mean egg count in pigs in these four states were 37.77 per cent with a distribution of 36.34, 47.31, 34.45 and 60.95 per cent infections with mean faecal egg count in terms of eggs per gram of faeces (EPG) was 1289.13, 2038.44, 475.19 and 897.26 in Meghalaya, Nagaland, Mizoram and Manipur, respectively. Among helminths, *Ascaris suum* infection (65.46%) *was* predominant in these four states followed by Strongyle spp. (45.96%), *Strongyloides* spp. (13.06%) and *Trichuris* spp. (16.66%). Among protozoa *Eimeria* spp. (34.0%) was recorded in all these four states and *Isospora* spp. (3.5%) was recorded in three states, except Meghalaya.

Murthy *et al.* (2014) reported the status of gastro-intestinal parasites in pigs maintained under different rearing systems in Shimoga region, Karnataka state. Out of 50 faecal samples examined from organized piggery farm, 19(38%) samples were found to be positive for different parasitic eggs. Out of 50 faecal samples screened from a Private farm, 28 (56%) harboured different parasites, whereas from 50 free range desi pigs faecal

samples examined, all the samples were found to be positive for one or other parasitic eggs/ova. *A.suum*, Strongyle, *Trichuris, Schistosoma spp*.eggs, *B.coli* cyst and coccidian oocysts were recorded.

Rout and Saikumar (2014) reported prevalence of gastrointestinal nematodes in slaughtered pigs of Bareilly, Uttar Pradesh and they found that 7.56 and 10.08 per cent of pigs had *Ascaris suum* and *Trichuris suis* infection respectively.

Allwin *et al.* (2015) studied the endoparasites in wild pigs in areas adjoining Western Ghats and Eastern Ghats of Tamil Nadu. They recorded *Ascaris suum, Trichuris suis, Strongyles* and *Strongyloides sp.* in wild pigs

Das *et al.* (2015) reported the prevalence of cryptosporidial infection in swine in Aizwal district of Mizoram. They recorded overall prevalence of 14.66 per cent, highest in summer (28.57%) followed by monsoon (19.23%) and winter (8.69%).

2.2. Prevalence of GI parasites in pigs in other countries

Martin *et al.* (1974) reported the prevalence of gastrointestinal parasites in pigs in Canada. The parasites recorded were *Ascaris suum, Trichuris suis*, *Oesophagostomum* spp. and *H. rubidus.*

A total of 516 swine herds were randomly examined from Denmark, Finland, Iceland, Norway and Sweden between 1986–1988 by Roepstorff *et al.* (1998) to know the prevalence and geographical distribution of intestinal parasites in pigs. They found that *Ascaris suum, Oesophagostomum* spp., *Isospora suis*, and *Eimeria* spp. were

common, while *Trichuris suis* and *Strongyloides ransomi* eggs were found sporadically in pigs in this region.

Permin *et al.* (1999) studied the prevalence of parasitic infections in local cross-bred pigs in the Upper East Region of Ghana. In a total of 259 faecal samples examined, 91 per cent were positive for parasite eggs. Among these the prevalence of *Eimeria* spp. was 77.2 per cent, *Isospora suis* was 27 per cent and *Balantidium coli* was 19.3 per cent. The following helminth eggs were recorded viz *Metastrongylus salmi* (19.3%); *Physocephalus sexalatus* (17.4%); *Oesophagostomum* spp./*Hyostrongylus rubidus* (60.6%); *Trichuris suis* (4.6%); *Ascaris suum* (12.7%); *Ascarops strongylina* (8.1%); *Brachylaemus suis* (1.9%); *Paragonimus suis* (0.8%); *Globocephalus urosubulatus* (2.7%); and *Schistosoma suis* (0.4%). Further, 60 slaughtered pigs were examined for adult worms and it was found that 96.7 per cent of them harboured parasites. *Metastrongylus salmi* (83.3%); *Oesophagostomum dentatum* (63.3%); *Oesophagostomum quadrispinulatum* (38.3%); *Hyostrongylus rubidus* (23.3%); *Ascarops strongylina* (76.7%); *Globocephalus urosubulatus* (20.0%), *Strongyloides* spp. (1.7%) and *Physocephalus sexalatus* (65.0%) were recorded.

Carstensen *et al.* (2002) examined nine Danish organic swine herds. It was found that the pigs reared in organic farms were infected with *Ascaris suum*, *Trichuris suis* and *Oesophagostomum* spp.

The prevalence of gastrointestinal parasites of free range farms (FRF), organic farms (OF) and conventional farms (CF) were recorded by Eijck and Borgstede (2005) in Netherlands. Infection with coccidia was 43.3% in FRF, 90.9% in OF, and 66.7 per cent

in CF. *Oesophagostomum* spp. was recorded in 25, 27.2 and 22.2 per cent of samples in FRF, OF and CF respectively. *Ascaris suum* was present in 50 per cent FRF, 72.7 per cent in OF and 11.1 per cent in CF. *Trichuris suis* 37.5 per cent of the FRF, 36.4 per cent in OF and 11.1 per cent in CF.

Out of the 3636 pigs faecal sample examined by Weng *et al.* (2005) in Guangdong Province, China, 209 (5.7%) were infected with *Trichuris suis*, 189 (5.2%) with *Ascaris suum*, 91 (2.5%) with *Oesophagostomum* spp., 905 (24.9%) with coccidia (*Eimeria* spp. or *Isospora suis*) and 1716 (47.2%) with *Balantidium coli*.

Faecal samples collected from 383 scavenging pigs in Burkina Faso were examined for gastrointestinal nematodes parasites using the Mc Master method by Tamboura *et al*. (2006). They found that 91 per cent were infected by one or more parasites. *Ascaris suum* (40 %; 100–1400 EPG) was the most prevalent parasite followed by *Strongyloides ransomi* (21%; 100–4200 EPG), *Oesophagostomum* spp. (18 %; 100–1 000 EPG), *Hyostrongylus rubidus* (11 %; 100–1800 EPG), *Globocephalus* spp. (10 %; 100–400 EPG) and *Trichuris suis* (1 %; 100–200 EPG). The age of the animal had no effect on the prevalence of *A. suum* whereas there were significant differences in age categories concerning *S. ransomi*, *H. rubidus*, *Oesophagostomum* spp. and *Globocephalus* spp. The high prevalence of these common parasites was not accompanied by elevated EPG values, which suggested the existence of moderate infections.

Nganga *et al.* (2008) studied the prevalence of helminth infection, species spectrum and worm burdens in Kenyan pigs. Out of 115 gastrointestinal tracts examined

78 (67.8%) had one or more helminth parasites, of which thirty six (31.3%) showed mixed infection. *Oesophagostomum dentatum* (39.1%), *Trichuris suis* (32.2%), *Ascaris suum* (28.7%), *Oesophagostomum quadrispinulatum* (14.8%), *Trichostrongylus colubriformis* (10.4%), *Trichostrongylus axei* (4.3%), *Strongyloides ransomi* (4.3%), *Hyostrongylus rubidus* (1.7%), *Ascarops strongylina* (1.7%) and *Physocephalus sexalutus* (0.9%) were recorded.

A total of 780 litters of suckling piglets from 104 farms and 267 mother sows were examined by Karamon *et al.* (2007) to study the prevalence of *Isospora suis* and *Eimeria* spp. in Poland. The study revealed that *I. suis* infection was found in 217 litters of suckling piglets (27.8%). Coccidia of *Eimeria* genus (*E. debliecki, E. poliata, E. suis*) were also detected. *E. polita, E. debliecki* and *E. suis* oocysts were detected in 15 litters (1.9%), 11 litters (1.4%) and 3 litters (0.4%) respectively. More than one *Eimeria* species occurred in 7 litters (0.9%). In five litters (0.6%) *I. suis* and *E. polita* occurred simultaneously. The mean OPG values in litters of piglets were: 5748.5 (7–150000) for *I. suis* and 3219.4 (7–43600) for *Eimeria* spp. oocysts.

Marufu *et al*. (2008) recorded the prevalence of gastrointestinal nematodes in indigenous Mukota pigs in Hama-Mavhaire communal area of Chirumhanzu District, Zimbabwe. A total of 143 randomly selected faecal samples from pigs were examined. Of the 143 pigs, 58.7% were positive for gastrointestinal (GI) nematodes and 17.5% had mixed infections. Four nematode species were identified; viz *Oesophagostomum* species (54.6%) being the most prevalent followed by *Strongyloides ransomi* (14%), A*scaris* species (7%) and *Trichuris suis* (4.2%).

Tiwari *et al.* (2009) studied the prevalence of intestinal parasites in pigs of Grenada, West Indies. Coprological examination was carried out on 221 pigs. The overall prevalence of intestinal parasites was 68.78 per cent. Four types of parasitic ova were identified including *Oesophagostomum* spp., *Strongyloides* spp. *Trichuris suis* and coccidia. There was no evidence of infection with *Ascaris suum* was observed.

A coprological survey was performed at a slaughterhouse in Osaka, Japan, by Matsubayashi *et al.* (2009). Out of 129 pigs reared in 8 prefectures, *Eimeria* spp., *Trichuris suis, Ascaris suum* and *Metastrongylus* spp. infections were found in 52 (40.3%), 32 (24.8%), 19 (14.7%) and 3 pigs (2.3%), respectively.

A study was conducted in and around Holleta by Abdu and Gashaw (2010) to assess the system of production and the prevalence of gastrointestinal parasites of swine. In a total of 388 faecal samples examined, *Ascaris suum* (13.9%), *Eimeria sp.* (5.6%), *Oesophagostomum sp.* (6.7%) were observed. Mixed infection was recorded in 13 pigs, among them 2 per cent were positive for *Ascaris suum* and *Eimeria sp.* and 1.14 per cent were positive for *Ascaris suum* and *Oesophagostomum sp*.

Ismail *et al.* (2010) studied the status of intestinal parasites in pigs and beef cattle in rural areas of Chungcheongnam-do, Korea. A total of 136 faecal samples of pigs were examined. The overall prevalence rate of 73.5 per cent for intestinal parasites, was found. The parasites recorded were *Balantidium coli, Ascaris suum*, and *Entamoeba* spp. infections 88 (64.7%), 24 (17.6%), and 5 (3.7%) samples respectively.

Lai *et al.* (2011) examined the faecal sample of 2971 pigs to assess the prevalence of intestinal parasites in China. Out of which 12.18 per cent were infected with *Ascaris suum,* 10.13 per cent with *Trichuris suis*, 10.13 per cent with *Oesophagostomum spp*., 6.53% with *Eimeria spp*., 5.02% with *Isospora suis*, 22.79 per cent with *Balantidium coli* and 6.60 per cent with *Cryptosporidium spp*. *B. coli* infection was common in all the age groups. Mixed infections were commonly noticed.

A study was carried out in rural communities in Kabale District in the South Western part of Uganda by Nissen *et al.* (2011) to estimate the prevalence of gastrointestinal nematode parasites in pigs based on coprological examination. A total of 106 pigs were examined and out of which 91 per cent was positive for nematode eggs. The following parasitic eggs of strongyles (89%), *Ascaris suum* (40%), *Trichuris suis* (17%) and spiruroid eggs (48%) were recorded.

A total of 242 faecal samples of pigs were examined from abattoirs in the province of Messina (Sicily, Italy), by Giarratana *et al.* (2012). *B. coli* infection rate was relatively high (86.06%) in commercial hybrid pigs and significantly lower (36.66%) in Nero Siciliano pigs.

Sowemimo *et al.* (2012) undertook a study from the Teaching and Research Farm of the University of Ibadan, Oyo State, Nigeria to determine the prevalence and intensity of gastrointestinal parasites in pigs. Out of 271 faecal samples examined, 97 (35.8%) were infected with one or more parasite species. Five types of parasites were identified, including *Trichuris suis, Ascaris suum,* human hookworm, *Stephanurus dentatus* and *Isospora suis.* Among these, *T. suis* was predominantly found.

Lin *et al.* (2013) studied the prevalence of common intestinal parasites in domestic pigs in Shaanxi province of China. A total of 1339 pig faecal samples were collected from pre-weaners (252), growers (360), fatteners (417), breeding sows and boars (310). Among them, 387 faecal samples were positive for intestinal parasites. Growers had the highest infection rate (41.4%), while pre-weaners had the lowest (22.2%) and 39 pigs had mixed infection. The common intestinal parasites were *Ascaris suum* (10.23%), *Strongyloides* spp. (6.49%), *Eimeria* spp. (6.35%) and *Cryptosporidium* spp. (4.63%).

Silva and Muller (2013) reported the parasites that inhabit the digestive system of wild boar. Out of 40 gastrointestinal tracts examined, 87.5 per cent were parasitized with *Ascaris suum, Trichostrongylus colubriformis, Oesophagostomum dentatum* and *Trichuris suis*.

Dey *et al.* (2014) examined 110 faecal samples and 20 viscera of pigs to investigate for endoparasites from different areas of Mymensingh (Bangladesh). In faecal sample examination, 96.4 per cent animals were infected with 12 different endoparasites, viz.., *Ascaris suum* (50.9%), *Strongyloides sp*.(29.1%), *Oesophagostomum sp*.(12.7%), *Trichuris suis* (9.1%), *Ancylostoma sp.* (3.6%), *Hyostrongylus rubidus* (1.8%), *Fasciolopsis buski* (14.6%), *Dicrocoelium sp.* (8.2%), *Schistosoma suis* (7.3%), *Eimeria spp*. (56.4%), *Balantidium coli* (40%) and *Isospora suis* (9.1%). Out of 20 viscera examined, 17(85%) pigs were found infected with *Ascaris suum* (65%), *Trichuris suis* (60%) and *Fasciolopsis buski* (55%).

Kumsa and Kifle (2014) studied the prevalence and major types of gastrointestinal parasites of pigs in Buraya district, Ethiopia. Out of 272 faecal samples examined from pigs, 36 (13.2%) were positive for one or more species of ova of internal parasites. Four types of parasitic ova were identified, namely oocysts of coccidia, eggs of *Ascaris suum*, strongyles and *Trichuris suis*. Overall prevalence was highest for *Eimeria* oocysts, followed by *A. suum,* and the lowest prevalence was recorded for *T. suis.*

Okorafor *et al.* (2014) evaluated the prevalence of gastrointestinal parasites in pigs slaughtered at Bodija Abattoir, Ibadan, Oyo State (Nigeria). Out of 101 faecal sample examined, 33 (32.67%) were infected by gastrointestinal parasites. The sex wise prevalence revealed that boars had higher prevalence of17 Per cent than sows 16 per cent. The four species of parasites identified showed prevalence of 20.79, 9.90, 0.99 and 0.99 per cent for *Isospora suis, Oesophagostomum dentatum, Trichuris suis* and *Metastrongylus salmi* respectively.

Out of 920 faecal samples of pigs, examined by Olaniyi (2014) in Nigeria, 55% per cent had *Hyostrongylus rubidus*, 23 per cent had *Ascaris suum,* 17 per cent had *Taenia solium* and 5 per cent had *Trichuris suis* infection.

Materials and Methods

III. MATERIALS AND METHODS

3.1. MATERIALS

3.1.1. Glass-wares and reagents

During the course of study Corning or Borosil brand of glassware were used for all the experiments and for storing the solutions. Tarsons graduated and capped 15 ml plastic test tubes were used for centrifugation.

3.1.2. Collection of faecal samples

Out of 725 faecal samples 320, 210 and 195 samples were collected from organized Private farms, organized Government farms and desi pigs respectively (Table 3.1). About 5-10 g fresh pooled faecal samples of pigs of different age groups were randomly collected from the floor of the pens and placed into disposable zip lock plastic covers labeled with farm name, house number, serial number, host age and collection date. Samples were transported to the laboratory and they stored in refrigerators at 4^0C and samples were processed within five days of collection (Ismail *et al*., 2010).

The breeds of pigs maintained in Private organized and Government organized farms were large white Yorkshire, Duroc and cross breds. Out of 725 faecal samples 150, 210 and 365 samples were collected from 0-6months, 6months-2yrs and above 2yrs of age group respectively.

In Private organized and Government organized farms deworming schedule was carried out once in three to four months and drugs used for deworming belong to benzimidazoles group mainly albendazole and fenbendazole.

Table 3.1: Faecal samples collected from different farms.

Sl. No.	Type of farm	Place	No. of samples
1	Private organized farms	Anekal	50
		Hoskote	30
		Kagglipura	50
		Harohalli	60
		Mulabagilu	50
		Bidadi	30
		Ramanagara	50
2	Government farms	Piggery unit GKVK B'lore	30
		Dept. of ILFC piggery unit Veterinary college B'lore	50
		State piggery farm Hessraghatta, Banglore	50
		Parappana Agrahara B'lore	40
		State piggery farm Kudige	40
3	Free range pigs (Desi pigs)	Pig holdings in and around Bangalore	195
	Total		**725**

3.1.3. Collection of worms

An attempt was made to assess the prevalence of gastrointestinal parasites in slaughtered pigs. Recovery of worms from stomach and intestine collected from different places are listed in Table 3.2. The stomach and intestine were brought to college laboratory in clean polythene covers for examination. In the laboratory, organs were examined in the fresh state. As described by Martin *et al.* (1974) stomach was opened

longitudinally along the greater curvature from the oesophageal opening to the pylorus. After evacuation of stomach contents was emptied into the tray to look for adult worms and stomach was washed with water and sieved for observed stomach worms. Similarly, small intestine and large intestine were examined by making an incision throughout the length of intestine. Intestinal contents were washed with water sieved for small worms. Mucosal wall of intestine was examined for worms which were attached. In both cases, attached worms were plucked using forceps and recovered worms were washed 3-4 times in normal saline for further examination. If any nodules are present on the mucosal surface of stomach and intestine, they were incised and were observed for the presence of parasites.

Table 3.2: Collections of worms from stomach and intestine of slaughtered pigs

Sl. No.	Place of collection	No. of carcass examined
1	BBMP slaughter house, Bangalore	75
2	Local slaughter house, Ramanagara	17
3	Postmortem conducted at IAH&VB	05
	Total	**97**

3.1.4. Staining of flukes

Trematodes were pressed between two slides, secured with thread and kept in formalin for two days and then they were washed in water to remove formalin. After washing, the worms were transferred into borax carmine alcoholic stain (Grenacher's Nice chemicals Pvt.Ltd, Cochin India) and kept overnight for staining. Then the worms were destained by using acid alcohol (1ml. HCL in 99ml. of 70 per cent alcohol) for a

short time till the excess stain was removed. They were dehydrated in ascending grades of ethyl alcohol 30-50, 70, 80 and 95 per cent and 3 changes in absolute alcohol for 15 mins each. Then the specimen were cleared in clove oil and mounted in Canada Balsam on a glass slide and cover slip was placed on the top.

3.1.5. Identification of nematodes

The worms that were recovered from the intestine and stomach were cleared in lactophenol and mounted in Canada balsam on a glass slide and cover slip was placed on the top and they were identified based on morphological characteristics as described by Soulsby (2005). Some of the nematodes were mounted in Rubin's mountant for examination. The recovered nematodes were preserved in 70 per cent alcohol glycerine.

3.2. Methods

The prevalence of gastrointestinal parasites was studied by faecal examination by direct method, sedimentation technique, flotation methods, formal ether method and intensity of infection was assessed by Modified Mc Master technique. The samples found positive for Cryptosporidium oocysts by sucrose flotation were further subjected for Modified Ziehl-Neelsen's staining for confirmation.

3.2.1. Direct method

Faecal examination by direct method, sedimentation technique and flotation methods were done as described by Kaufmann (1996).

Samples collected were mixed properly and a small quantity of faeces from each sample was placed on a glass slide, mixed with a drop of water and spread out uniformly

on slide, covered with a glass cover slip and examined directly under the microscope for presence of helminth ova and protozoan oocysts/cysts.

3.2.2. Sedimentation method

Five to ten grams of faeces was placed in a mortar and approximately 50-100ml of tap water was added and mixed thoroughly with the help of pestle until all the faecal material was broken down. The mixture was poured through a sieve with an aperture of 500-800 µm to remove large lumps as well as coarse material. The strained fluid was transferred to centrifuge tubes and centrifuged at 2000 rpm for 2 minutes. Supernatant was discarded and sediment was mixed well with the help of a glass rod. A small quantity of sediment was mixed with a drop of water on slide. Glass cover slip was applied and examined under low power objective of the microscope.

3.2.3. Centrifugal flotation method

The procedure for sedimentation method was followed, and then the sediment was mixed with a saturated solution of sodium chloride with specific gravity of 1.20 and sucrose solution with specific gravity of 1.25 in centrifugation tube and centrifuged at 1000 rpm for 2 minutes. The materials on the surface was examined by touching the surface of the solution with the coverslip and transferred onto the microscopic slide for observation.

3.2.4. Formal ether method

The faecal samples were subjected to formal ether method as described by Foreyt (1997) and Beaver *et al.* (1984) with slight modifications for detection of *Schistosoma* eggs. The method employed was as follows:

- One gram of faeces was mixed with 15ml of normal saline.
- The mixture was strained and poured into 15ml centrifuge tubes.
- The tubes were centrifuged at 1500 rpm for 2 minutes.
- The supernatant was discarded and 10ml of 10 per cent formalin was added to the sediment.
- The tubes were allowed to stand for 10 minutes.
- Petroleum ether (3ml) was added to the tubes, a stopper was applied and the contents in the tubes were shaken vigorously.
- The mixture was centrifuged for 2 minutes at 1000 rpm.
- The debris on the top of the tubes were removed and the rest of fluid was decanted.
- A part of sediment was examined on a microscopic slide for parasitic eggs.

3.2.5. Modified Ziehl-Neelsen's staining

The samples found positive for Cryptosporidium oocysts by sucrose flotation were further confirmed by MZN staining (hot method using kit of Himedia Company) as per the procedure described by Henriksen and Pohlenz (1981).

- Thin smears of faecal sediment were made on a clean grease free glass slide and air-dried.
- The smears were fixed transiently over a flame.
- The smears were stained with strong carbol fuchsin solution for 5 minutes. In hot method, after pouring the stain, slide was heated until the steam appeared without allowing it to boil. Additional stain was then poured when the slide dried.

- After staining, the smears were washed in running tap water for 1-2min.
- The slides were subsequently decolorized in 5 per cent sulphuric acid for 30sec.
- Again the smears were washed with tap water for 1-2min and counterstained with 3 per cent methylene blue for 1 min.
- The smears were finally washed in tap water and air-dried and were examined microscopically under oil immersion (100X) for *Cryptosporidium* oocysts.

3.2.6. Quantitative faecal examination

3.2.6a Modified Mc Master Method

Quantitative estimation of strongyle eggs and Eimeria oocysts were done by Modified Mc Master Method as described by Zajac and Conboy (2012).

To 3g of faeces, 42ml of water was added and soaked for two minutes. The pellets were homogenized by placing in a jar containing 45 glass beads (8mm) and shaken vigorously to break the faecal pellets. The mixture was passed through a sieve and 15ml of the filtrate was centrifuged for 2 minutes at 1500 rpm and supernatant was discarded. To the sediment, 15ml of saturated sodium chloride solution was added, mixed well and using a Pasteur pipette the chambers of Mc Master's slide was filled. The strongyle eggs and *Eimeria* oocysts in each chamber under low power were counted and multiplied by 100 to obtain eggs per gram (EPG) of faeces and oocysts per gram (OPG) of faeces respectively.

3.2.7. Identification of *Eimeria* oocysts

When unsporulated oocysts were detected in the pig faecal samples, the sediment was resuspended in 2.5 per cent (w/v) potassium dichromate solution, and kept at room temperature. The sediment was examined daily in order to check for sporulation. Identification of sporulated oocyst was made on the basis of morphology, morphometry and sporulation time as described by Soulsby (2005).

3.2.8. Coproculture and Identification of third stage larvae

The faecal samples from individual farms found positive for Strongyle eggs were kept for culture at 27 ^{0}C for 14-21 days and larvae were harvested using Baermann's apparatus as described by Zajac and Conboy (2012) in order to differentiate between 3rd stage larvae of common strongyles found in the pigs.

3.2.8.1. Procedure for coproculture

The faeces were broken up finely using a large pestle and mortar. Based on consistency of faeces, few drops of water or animal charcoal were added in case of dry and wet faeces. Glass culture dishes were then filled with the mixture closed and kept in a dark area at room temperature for 10 days. The cultures were stirred each day to inhibit the fungal growth and also to aerate the lower layers of the culture to get uniform moisture.

3.2.8.2. Recovery of larvae from culture

After 10 days of incubation, the culture material was transferred to the Baermann's apparatus, which consisted of a test-tube fitted at the end of the rubber

tubing and a piece of cheese cloth placed in the sieve in the funnel. The funnel was filled with warm water until it raised about half above the layer of the cloth in the sieve and the water was left to cool to about 35^0C – 45^0C. The cultured faecal sample was spread evenly over the cloth and allowed to stand overnight. The apparatus was clamped off at the rubber tubing, the clamp opened and contents withdrawn into the test-tube. The entire filtrate was collected in a plastic jar and was centrifuged at 1500 rpm for 2 minutes to concentrate the larvae.

3.2.8.3. Identification of larvae

A small drop of the suspension of larvae was placed on a microscopic slide with the help of Pasteur pipette and a drop of Lugol's Iodine solution was added to kill the larvae. The mixture was mixed carefully and cover slip applied gently and then examined under the microscope. Nematode larvae were examined and identified as per Zajac and Conboy (2012).

3.3. Microscope calibration

The ability to measure the size of parasities organisms and structures is very helpful when identifying unusual parasites or where different organisms are similar in appearance but differ in size. For measurement, a micrometer disc, also known as reticle, is inserted into the ocular tube of the microscope and calibrated against a known reference in the form of a stage micrometer. Each objective lens of the microscope must be individually calibrated with the ocular lens/ micrometer combination to be used, and the calibration posted close to the microscope for easy reference.

Calibration of the 10X objective illustrates the procedure for calibration of the micrometer as per Zajac and Conboy (2012).

- To calibrate the 10X objective, place the stage micrometer on the stage of the microscope and focus until the lines are sharp.
- Superimpose any convenient numbered line of the ocular micrometer.
- Find the two lines that are exactly superimposed.
- Repeat this procedure for each objective lens to be calibrated on the microscope.

To use the calibrated microscope, superimpose the ocular micrometer scale on an egg or cyst and count the number of divisions subtended by the specimens.

Results

IV. RESULTS

In the present study to record prevalence of gastrointestinal parasites in pigs, faecal samples from different managemental system in and around Bangalore and gastrointestinal tracts from the slaughter houses were screened over a period of eight months during 2014-15.

4.1. Prevalence of gastrointestinal parasites of pigs in different managemental systems by faecal examination

The number of pigs positive for different gastrointestinal parasites and the overall prevalence rate evaluated by different methods viz., direct examination, sedimentation method, flotation method, formal ether method and acid fast staining technique are presented in Table 4.1 and Fig. 4.1.

Out of 725 faecal samples examined, the overall prevalence rate recorded for gastrointestinal parasites in pigs was 73.7 per cent. *Balantidium coli* (35.7%) was the most prevalent gastrointestinal parasite followed by *Ascaris suum* (26.3%), *Eimeria* oocyst (15.7 %), *Trichuris suis* (14.2 %), Strongyles (7.31 %), *Ascarops sp*. (4.9 %), *Physocephalus sp*. (2.06 %), *Fasciolopsis buski* (1.9 %) and *Metastrongylus sp*. (0.9 %). Occurrence of mixed infections was observed in many samples and mixed infection of *B. coli*, *Eimeria sp.* and *A. suum* was predominant followed *by B.coli* and *A. suum* together.

4.1.1. Faecal sample examination of pigs from free range pigs

In a total of 195 faecal samples examined from free range pigs, the overall prevalence of gastrointestinal parasites recorded was 91.2 per cent. *A. suum* infection

(57.4%) was found to be highest followed by *B. coli* (35.4%), *T. suis* (31.79%), *Eimeria sp.* (21.0%), Strongyles (18.9%), *Ascarops sp.* (18.4 %), *Physocephalus sp*. (7.6%), *F. buski* (4.6%), and *Metastrongylus sp.* (2.0%).

4.1.2. Faecal sample examination of pigs from Government organized farms

Out of 210 faecal samples examined from four different Government farms, the prevalence of gastrointestinal parasites was found to be 68.1 per cent. *B. coli* infection (46.6%) was found to be the highest followed by *A. suum* (19.5%), *Eimeria sp.* (7.6%), *T. suis* (4.7%), Strongyles (3.3%), *F. buski* (0.9%) and *Metastrongylus sp.* (1.4%)

4.1.3. Faecal sample examination of pigs from Private organized farms

In a total of 320 faecal samples examined from Private organized farms, the prevalence of gastrointestinal parasites was found to be 66.8 per cent. *B. coli* infection was found to be highest (30.6%) followed by *Eimeria sp.* (17.8 per cent), *A. suum* (11.8%), *T. suis* (9.6%), Strongyles (2.8%) and *F. buski* (0.9%).

In the present study, the overall prevalence rate of gastrointestinal parasites was found to be highest in unorganized farms (91.2%). However, Private organized and Government organized farms showed almost similar prevalence rate of 66.8 and 68.1 per cent respectively.

Analysis of data by one way analysis of variance (ANOVA) revealed a significant difference in the prevalence of parasites in different managmental system ($P \leq 0.05$).

Out of 725 faecal samples examined, the mixed infection rate recorded was 51.7 per cent. Analysis of data by chi-square test revealed that there was a significant difference ($P \leq 0.0001$) between occurrence of mixed infection and single infection and also between total positive and negative samples.

F. buski eggs (Plate 4.1) were large with thin shell and an operculum was present. They were yellowish in colour and measured 132.6 x76.3 µm.

Two types of spirurid eggs viz.,*Ascarops sp*. (Plate 4.6) and *Physocephalus sp.* (Plate 4.7) were recorded in present study. The eggs are appeared similar in size on faecal examination. *Ascarops sp*. measured 37.2x19.8µm (length x breadth) and *Physocephalus sp.* eggs measured 35.32 x 16.7µm. The eggs showed thick shell wall with a developing larva inside. *A. suum* eggs (Plate 4.3 and 4.4) were oval in shape, thick shell with mammilation, brown in colour and measured 53.8 x 45.6 µm. *T. suis* eggs (Plate 4.5) were barrel in shape with transparent plugs on both the ends and measured 53.7 x 24.2 µm. *Metastrongylus* sp. eggs (Plate 4.8) measured 48.9x 39.1 µm, had thick, rough shell and contained developed larvae. Strongyle eggs were thin shelled with segmented yolk inside identification of strongyle species were done by faecal culture.

B. coli cysts (Plate 4.9) were spherical in shape, yellowish green in colour and measured 55.2 µm in diameter. Different size of unsporulated *Eimeria* oocysts were recorded during present study. *Eimeria* species were identified by keeping them for sporulation.

4.2. Age wise prevalence of gastrointestinal parasites of pigs basd on faecal sample examination

The prevalence of GI parasites in different age groups of pigs is presented in Table 4.2 and Fig. 4.2. In the present study, prevalence of parasites was higher in age group of 0-6months (83.33%) followed by 6months- 2yrs (72.3%) and above 2yr (70.6%).

Among 0-6months age group of pigs, *B.coli* infection (52%) was found to be highest followed by *Eimeria sp.* (27.33%), *T. suis* (22%), *A.suum* (18.66%) and Strongyles (9.33%). Among age groups of 6months-2yrs *B. coli* infection (34.2%) was found to be the highest followed by *A. suum* (27.6%), *Eimeria sp.* (13.8%), *T. suis* (11.4%), Strongyles (8.5%), *Ascarops sp.*(5.2%) and *F. buski* (0.9%). In pigs of age group above 2yrs, *B.coli* infection (29.04%) was found to be highest followed by *A.suum* (28.7%), *T. suis* (12.6%), *Eimeria sp.* (12.05%), Strongyles (6.03%) *Ascarops sp.* (6.84%), *Physocephalus sp*. (4.1%), *F. buski* (3.2%) and *Metastrongylus sp*. (1.91%).

In the present study trematode infection was higher in older animals above 2yrs of age than young ones whereas, protozoan infection was higher in young animals (0-6months) than older ones. Whereas prevalence of nematode infection was almost similar in all age groups.

Analysis of data by one way analysis of variance (ANOVA) revealed a significant difference in the prevalence of parasites in different age groups of animals ($P \leq 0.05$).

4.3. Quantitative estimation of strongyle ova

To know the severity of strongyles in pigs under different management system, Eggs per gram (EPG) counts were done by Mc Master's technique.

The EPG counts of strongyle eggs are presented in Table 4.3 and Fig. 4.3. The overall mean egg count of strongyle ova in pigs was 1304.03±349.72 with a range of 167-5500 EPG. The mean EPG count of Private organized farms was 433.33±123.6 with a range between 100-1200 whereas in Government organized farms, the EPG count was 1057.14±477.56 with a range 100-3800 and in free range pigs EPG count was 2421.62±448.02 with a range of 300-11500.

4.4. Third stage larvae of different strongyle species obtained from faecal culture of pigs

Fifty three faecal samples of pigs positive for strongyle ova (Plate 4.2) were kept for culture to obtain third stage larvae. Three type of strongyle larvae viz., *Oesophagostomun sp, Hyostrongylus rubidus* and *Trichostrongylus sp.* were identified based on characters of 3rd stage larvae are presented in the Table 4.4 and Fig. 4.4.

The prevalence of *Oesophagostomum* larvae (100%) was highest followed by *Trichostrongylus* larvae (11.32%) and *Hyostrongylus rubidus* larvae (3.77%) in the present study. *Oesophagostomum* larvae were medium in size with 16 triangular intestinal cells and the tail sheath was long and filamentous (Plate 4.26 and 4.27). *Hyostrongylus rubidus* larvae were long and slender with digitiform process at the posterior end consisting of short tail sheath (Plate 4.28). *Trichostrongylus* larvae had rounded head with short tail sheath (Plate 4.29).

4.5. Quantitative estimation of *Eimeria* oocysts

The estimation of oocyst per gram (OPG) counts are presented in Table 4.5 and Fig. 4.5. The overall mean OPG of *Eimeria* oocyst in pigs was 5348.64±767.56 with a range of 734-25536 OPG. The mean OPG count for Private organized farms was 5756.14±1051.85 with a range from 400-45300, in Government organized farms the OPG count was 3606.87±530.6 with a range between 600-6800 and in free range pigs OPG count was 6682.92±720.24 with a range of 1200-24500.

4.6. Prevalence of different species of *Eimeria* in pigs

Four species of *Eimeria* (Plate 4.30) viz., *E. perminuta, E. suis, E. debliecki* and *E. scabra* were identified based on the sporulation time, shape and micrometry of oocyst (Table 4.6 and Fig. 4.6). *E. debliecki* (86.84%) was found to be highest followed by *E. suis* (71.05%), *E. scabra* (61.40%) and *E. perminuta* (40.3%).

E. perminuta oocysts were spherical with a rough oocyst wall, micropyle was absent and sporulation occurred in 11 days. Its length and breadth were 13.8 and 13.1µm respectively (Plate 4.30), *E. debliecki* oocysts were ovoid, oocyst wall was smooth, micropyle was absent and sporulation was observed in 4 days. Its length and breadth were 23.6 and 15.4µm respectively (Plate 4.31), *E. scabra* oocysts were ellipsoidal, oocyst wall was smooth, colourless, micropyle was absent and sporulation was observed in 12 days. Its length and breadth were 31.6 and 20.2µm respectively (Plate 4.32) and *E. suis* oocysts were subspherical with smooth wall, colourless without micropyle, sporulation completed within 9 days. Its length and breadth was 16.5 and 13.2µm respectively (Plate 4.33).

4.7. Comparison of five methods in detecting gastrointestinal parasites of pigs

The data on comparision of five methods in detecting gastrointestinal parasites of pigs is presented in Table 4.7 and Fig. 4.7. It was observed that Floatation method using Saturated NaCl and sucrose was highly sensitive in detection of *Eimeria* oocysts, ova of Strongyles, *A.suum, T. suis, Ascarops sp.*, *Physocephalus sp.* and *Metastrongylus spp*. in comparison with other techniques.

Analysis of data by one way analysis of variance (ANOVA) revealed a significant difference between the tests in detection of gastrointestinal parasites by different methods ($P \leq 0.05$).

4.8. Examination of gastrointestinal tracts of pigs.

The different gastrointestinal parasites recovered from GI tract are presented in Table 4.8 and Fig. 4.8. In a total 97 GIT of pigs examined 85 (87.62%) were found positive for different adult parasites. The parasites recovered from stomach of pigs included *Simondsia paradoxa*, *Ascarops strongylina* and *Physocephalus sexalatus* with a per cent of 4.12, 79.38 and 63.91 respectively. From the small intestine *Fasciolopsis buski* (2.06%) and *Ascaris suum* (54. 63%) were recovered and from large intestine *Trichuris suis* (37.11%), *Oesophagostomum dentatum* (9.27%) and *O. quadrispinulatum* (5.15%). Among these *A. strongylina*, *P. sexalatus* and *S. paradoxa* were recorded for the first time in Karnataka.

4.8.1. Examiation of stomach

Three species of Spirurids were observed on examination of stomach in the study viz., *A. strongylina, P. sexalatus* and *S. paradoxa.* On gross examination, *A. strongylina* and *P. sexalatus* were red in colour, small and slender worms. *A. strongylina* and *P. sexalatus* found attached to the stomach wall under the layer of thick mucus (Plate 4.10), whereas *S. paradoxa* females were found embedded in small cysts in the stomach wall with anterior end projecting (Plate 4.11). The posterior end of female worm of *S. paradoxa* was globular filled with eggs (Plate 4.16) and male worms of *S. paradoxa* were long and slender freely found in the stomach wall (Plate 4.17 and 4.18) male worms measured13.2mm and female worms 15mm long.

Differentiation of *A. strongylina* and *P. sexalatus* were difficult because of their similarity in size and morphology of posterior end of males. Hence, the identification of these species was done mainly based on the structure of pharynx.Male worms measured 8.2 mm and female worms measured 16.9 mm in lenghth. In cleared specimens the wall of pharynx of *A. strongylina* with spiral thickening (Plate 4.19), posterior end of male *A. strongylina* showed two unequal spicules of which left spicule was longer than right one (Plate 4.20) male worm measured 12.4 mm and female17.1 mm long. In *P. sexalatus* the pharynx wall had a single spiral thickening with complete rings in the middle portion (Plate 4.21).

4.8.2. Examination of small intestine

A. suum is a large thick worm recovered from the small intestine of pigs which was identified based on the gross appearance, in cleared specimens trilobed lips were

present at the anterior end (Plate 4.12 and 4.13), male worms measured 22.2cm x 3mm and female worms measured 42.1cm x 5mm (l x b).

F. buski a oval large thick fleshy fluke without shoulders and slightly broader posteriorly than anteriorly. It had a short pharynx followed by unbranched caeca which reached almost up to posterior end of the body. Testes were branched, tandem in position and posteriorly placed (Plate 4.15).

4.8.3. Examination of large intestine

T. suis is a small worms were recovered from large intestine, in which anterior end was long and slender embedded in mucosa of large intestine whereas posterior end of males was spirally coiled (Plate 4.14), male worms measured 38 .9 and female worms measured 42.3mm in length.

Two species of *Oesophagostomun* were recovered from the large intestine. The buccal capsule of *O. dentatum* was parallel and oesophagus was club shaped without any swelling at the anterior end (Plate 4.22) and without any divergence posteriorly. In *O. quadrispinulatum* buccal capsule sides were not parallel, diverging posteriorly, oesophagus was vase shaped, swollen at anterior end (Plate 4.23) and the Posterior end of *O. quadrispinulatum* male had well developed bursa with two equal spicules (Plate 4.24).

In the present study, *A. suum, T. suis, Oesophagostomun sp., Ascarops sp. Physocephalus sp.* and *F. buski* were recorded in both faecal sample and GI tract examination. However, *S. paradoxa* was recorded only in GI tract examination and

Hyostrongylus rubidus and *Trichostrongylus sp.* were recorded and identified only after recovering from faecal cultures by Baermann's apparatus.

4.9. Prevalence of zoonotic gastrointestinal parasites

The data of zoonotic important parasites recovered from faecal sample and GI tract examination is presented in Table 4.9 and Fig. 4.9. The gastrointestinal parasite of pigs with zoonotic significance encountered in the present study included *F. buski, A. suum* and *B. coli* of all were detected in the faecal samples with a percentage of occurrences of 1.9, 26.3 and35.7 respectively. In GI tracts only *F. buski* and *A. suum* worm were detected with a percentage of 2.06 and 54.63 respectively.

Table 4.1. Prevalence of parasites in faecal sample of pigs in different managemental systems

Type of farms	No. of samples examined (%)	No. of samples positive (%)	No. of samples negative (%)	No. of samples with single infection (%)	No. of samples with mixed Infection (%)	No. of faecal samples Positive for ova of different gastrointestinal parasites								
						F. buski (%)	Strongyles (%)	*A. suum* (%)	*T. suis* (%)	*Ascarops sp.* (%)	*Physocephalus sp.* (%)	*Metastrongylus sp.* (%)	*Eimeria Oocyst* (%)	*B. coli Cyst* (%)
Private organized farm	320	214 (66.8)	106 (33.1)	96 (30)	118 (36.8)	3 (0.9)	9 (2.8)	38 (11.8)	31 (9.6)	0 (0.0)	0 (0.0)	0 (0.0)	57 (17.8)	98 (30.6)
Govt organized farm	210	143 (68.1)	67 (31.9)	46 (21.9)	97 (46.1)	2 (0.9)	7 (3.3)	41 (19.5)	10 (4.7)	0 (0.0)	0 (0.0)	3 (1.4)	16 (7.6)	92 (46.6)
Free range pigs	195	178 (91.2)	17 (8.7)	18 (9.2)	160 (82.1)	9 (4.6)	37 (18.9)	112 (57.4)	62 (31.7)	36 (18.4)	15 (7.6)	4 (2.0)	41 (21.0)	69 (35.4)
Total	**725**	**535 (73.7)**	**190 (26.3)**	**160 (22.0)**	**375 (51.7)**	**14 (1.9)**	**53 (7.31)**	**191 (26.3)**	**103 (14.2)**	**36 (4.9)**	**15 (2.06)**	**7 (0.9)**	**114 (15.7)**	**259 (35.7)**

Table 4.2. Age wise prevalence of gastrointestinal parasites of pigs

Different age group	No. of samples examined (%)	No. of samples positive (%)	No. of samples negative (%)	No. of samples with single infection (%)	No. of samples with mixed infection (%)	No. of faecal samples Positive for ova of different gastrointestinal parasites								
						F. buski (%)	Strongyles (%)	*A. suum* (%)	*T. suis* (%)	*Ascarops sp.* (%)	*Physocephalus sp.* (%)	*Metastrongylus sp.* (%)	*Eimeria Oocyst* (%)	*B. coli Cyst* (%)
0-6 months	150	125 (83.33)	25 (16.66)	29 (19.33)	96 (64)	0 (0.0)	14 (9.33)	28 (18.66)	33 (22)	0 (0.0)	0 (0.0)	0 (0.0)	41 (27.33)	78 (52)
6 months-2yrs	210	152 (72.3)	58 (27.6)	48 (22.8)	104 (49.5)	2 (0.95)	17 (8.5)	58 (27.6)	24 (11.4)	11 (5.2)	0 (0.0)	0 (0.0)	29 (13.8)	72 (34.2)
Above 2 yr	365	258 (70.6)	107 (29.3)	83 (22.7)	175 (47.9)	12 (3.2)	22 (6.03)	105 (28.7)	46 (12.6)	25 (6.84)	15 (4.1)	7 (1.91)	44 (12.05)	106 (29.04)
Total	**725**	**535 (73.7)**	**190 (26.3)**	**160 (22.0)**	**375 (51.7)**	**14 (1.9)**	**53 (7.31)**	**191 (26.3)**	**103 (14.2)**	**36 (4.9)**	**15 (2.06)**	**7 (0.9)**	**114 (15.7)**	**259 (35.7)**

Table 4.3. The range and mean faecal strongyle egg count of pigs from different farming system

Type of farm	Range	Mean±SE
Private organized farm	100-1200	433.33±123.6
Govt organized farm	100-3800	1057.14±477.56
Unorganized Farm	300-11500	2421.62±448.02
Total	**167-5500**	**1304.03±349.72**

Table 4.4. Third stage larvae of different strongyle species obtained from faecal culture of pigs

Type of farm	**No. of faecal culture**	**No. of sample positive for different species of Strongyle third stage Larvae**		
		Hyostrongylus rubidus	***Oesophagostomum sp.***	***Trichostrongylus sp.***
Private organized farm	9	0 (0.0%)	9 (100%)	0 (0%)
Govt organized farm	7	0 (0.0%)	7 (100%)	1 (14.2%)
Unorganized Farm	37	2 (5.4%)	37 (83.78%)	5 (15.51%)
Total	**53**	**2 (3.77%)**	**53 (100%)**	**6 (11.32%)**

Table 4.5. The range and mean faecal *Eimeria* oocysts count of pigs from different managemental systems

Type of farm	Range	Mean±SE
Private organized farm	400-45300	5756.14 ± 1051.85
Govt organized farm	600-6800	3606.87 ± 530.6
Unorganized Farm	1200-24500	6682.92 ± 720.24
Total	**734-25534**	$\mathbf{5348.64 \pm 767.56}$

Table 4.6. Prevalence of different species of *Eimeria* in pigs

Type of farm	No. of faecal sample kept for sporulation	Single infection	Multiple infection	No. of Sample positive for different Species of *Eimeria*			
				E. perminuta	***E. suis***	***E. debliecki***	***E.scabra***
Private organized farm	57	11 (19.29%)	46 (80.70%)	22 (38.59%)	41 (71.92%)	51 (89.47%)	35 (61.40%)
Govt organized farm	16	4 (25.0%)	12 (75.0%)	6 (37.5%)	10 (62.5%)	12 (75%)	8 (50%)
Unorganized Farm	41	8 (19.5%)	33 (80.48%)	18 (43.90%)	30 (73.17%)	36 (87.80%)	27 (65.85%)
Total	**114**	**23 (20.14%)**	**91 (79.82%)**	**46 (40.35%)**	**81 (71.05%)**	**99 (86.84%)**	**70 (61.40%)**

Table 4.7. Evaluation of different faecal examination methods in the detection of gastrointestinal parasites of pigs

Methods	**No. of sample examined**	***F.buski* ova**	**Strongyle ova**	***A. suum* ova**	***T. suis* ova**	***Ascarops sp*. ova**	***Physocephalus sp*.ova**	***Metastrongylus sp*. ova**	***Eimeria sp.* Oocyst**	***B. coli* cyst**
Direct smear examination	725	9 (1.24%)	36 (4.9%)	156 (21.51%)	73 (10.06%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	23 (3.17%)	231 (31.8%)
Sedimentation technique	725	14 (1.93%)	47 (6.48)	182 (25.10%)	84 (11.58%)	20 (2.75%)	4 (0.55%)	6 (0.82%)	56 (7.72%)	259 (35.7%)
Flotation method (NaCl)	725	0 (0.0%)	61 (8.4%)	189 (26.0%)	103 (14.2%)	38 (5.24%)	15 (2.06%)	5 (0.68%)	119 (16.4%)	0 (0%)
Flotation method (sucrose)	725	0 (0.0%)	61 (8.4%)	198 (27.31%)	101 (13.93%)	41 (5.6%)	12 (1.6%)	7 (0.96%)	119 (16.4%)	0 (0%)
Formal ether method	725	11 (1.51%)	51 (7.03%)	190 (26.20%)	98 (13.51%)	29 (4.0%)	9 (1.2%)	5 (0.68%)	72 (9.93%)	0 (0.0%)

Table 4.8. Gastrointestinal parasites recovered from the GIT of pigs

Location	No. of pigs examined	Parasites	Positive Percentage (%)
Stomach	97	*Simondsia paradoxa*	4 (4.12)
		Ascarops strongylina	77 (79.38)
		Physocephalus sexalutus	62 (63.91)
Small intestine	97	*Fasciolopsis buski*	2 (2.06)
		Ascaris suum	53 (54.63)
Large intestine	97	*Oesophagostomum dentatum*	9 (9.27)
		Oesophagostomum qudrispinulatum	5 (5.15)
		Trichuris suis	36 (37.11)

Table 4.9. Prevalence of zoonotic importance G I parasites in pigs

Samples	*F. buski* (%)	*A. suum* (%)	*B. coli* (%)
Faecal samples	1.9	26.3	35.7
GI tracts.	2.06	54.63	-

Fig. 4.1. Prevalence of parasites in faecal sample of pigs in different managemental systems

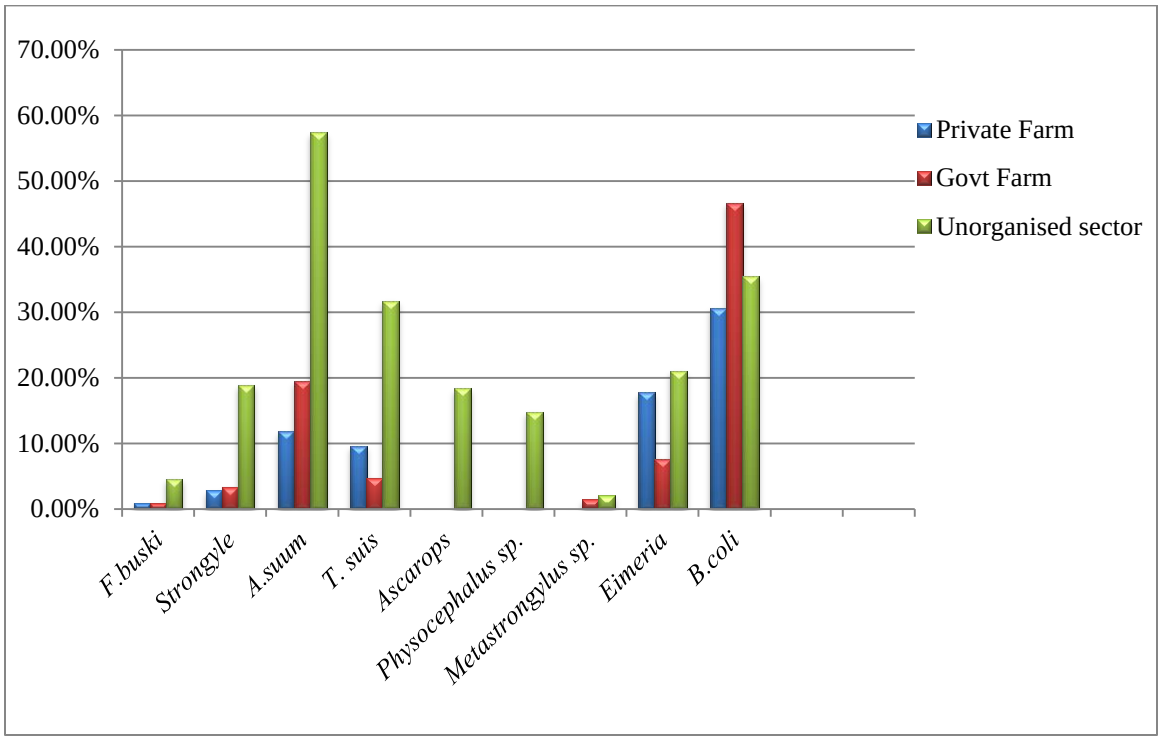


Fig 4.2. Age wise prevalence of gastrointestinal parasites of pigs

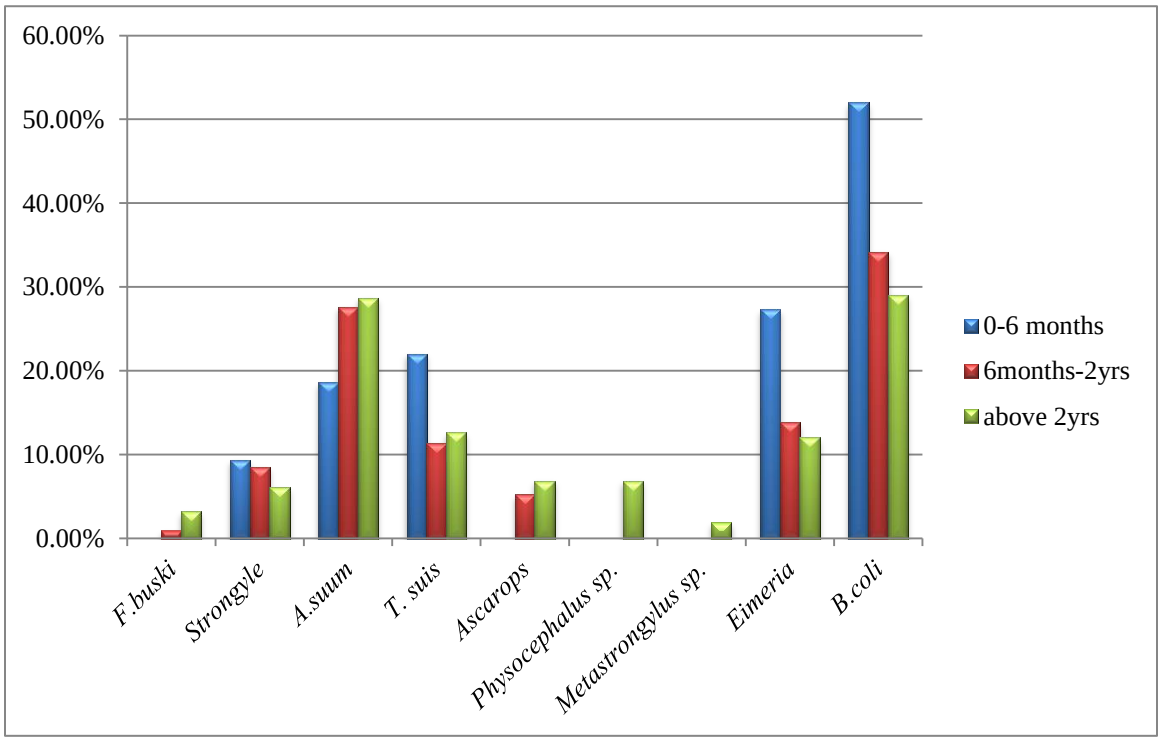


Fig. 4.3. Mean faecal strongyle egg count of pigs from different managemental systems

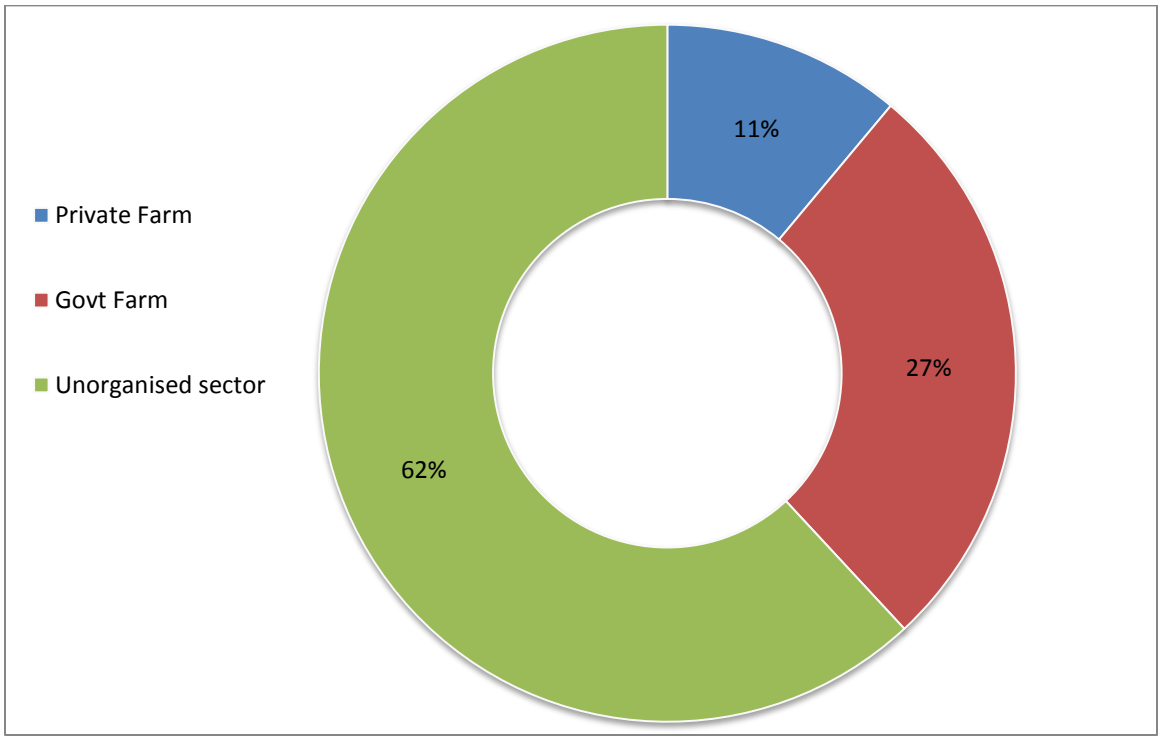


Fig. 4.4. Third stage larvae of different Strongyles obtained from faecal culture of pigs

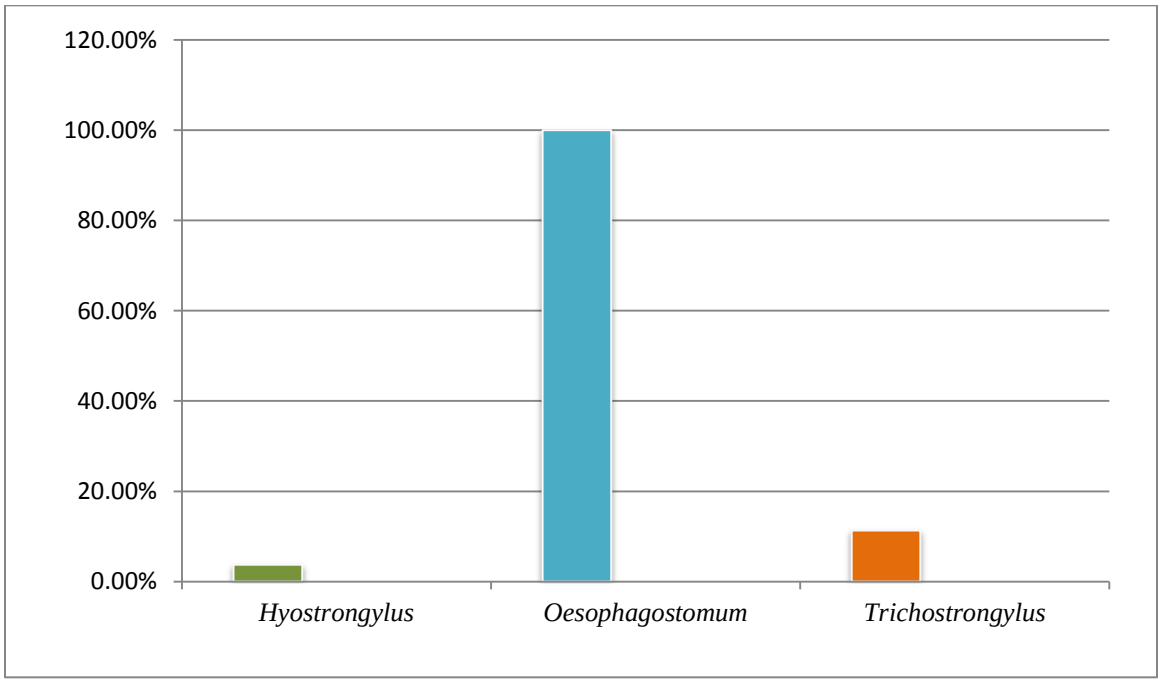


Fig. 4.5. Mean faecal *Eimeria* oocysts count of pigs from different managemental systems

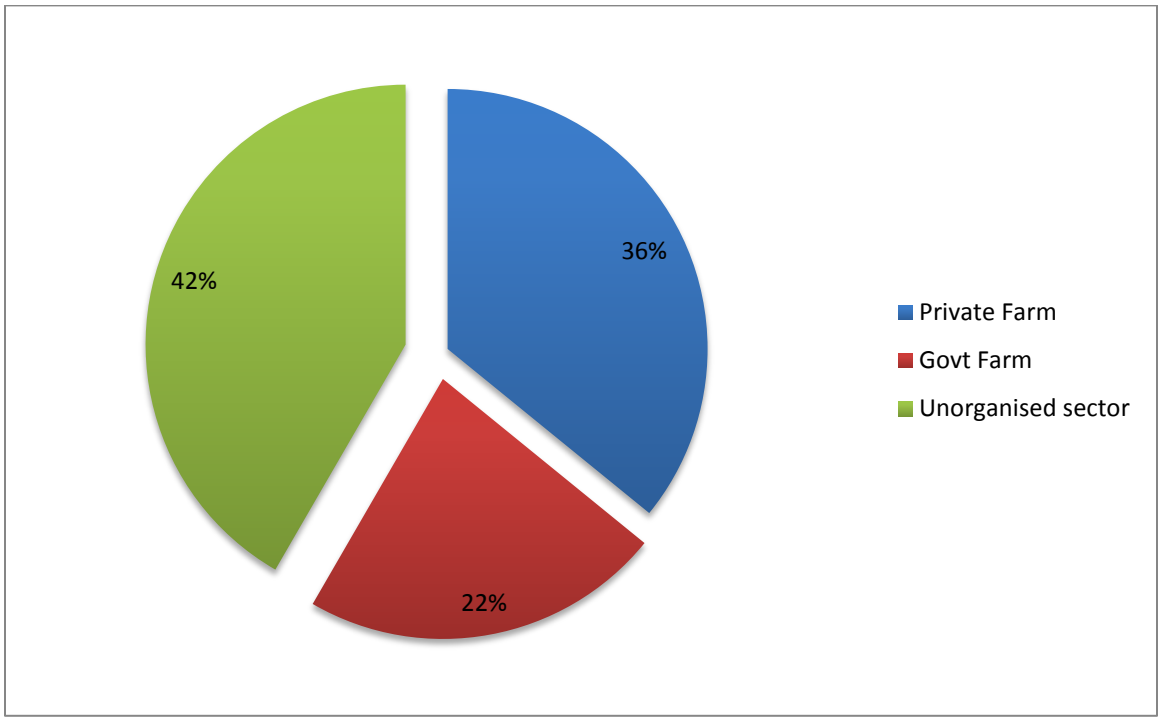


Fig. 4.6. Prevalence of different species of *Eimeria* in pigs

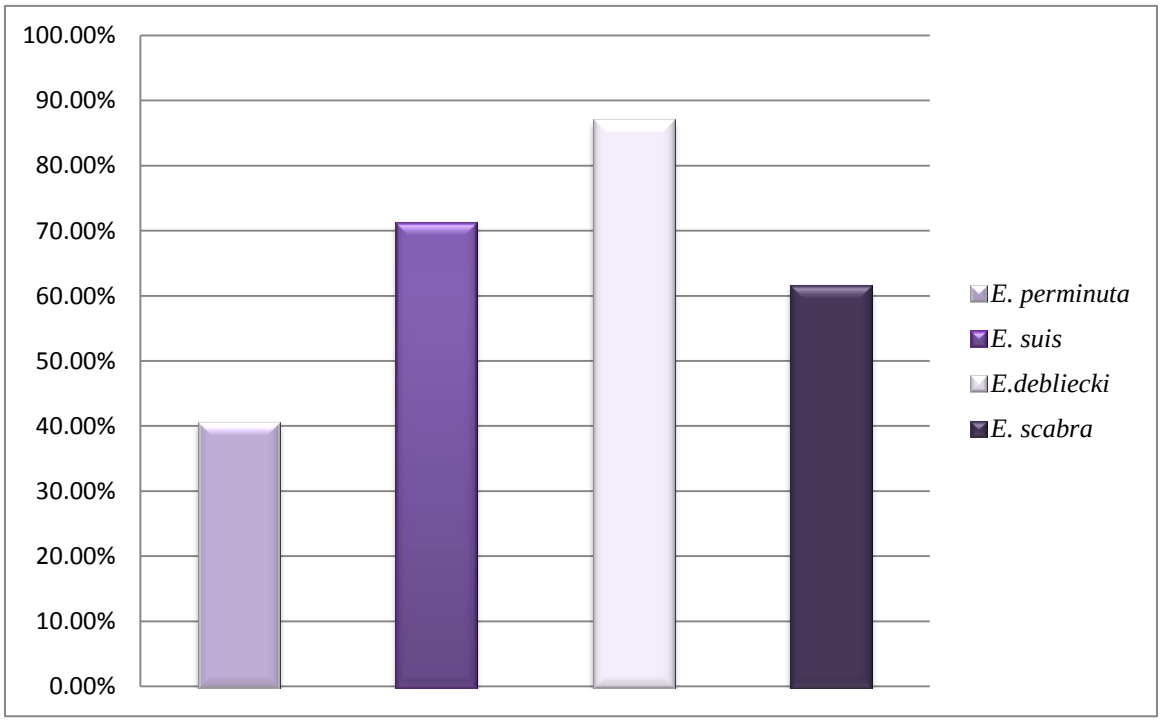


Fig. 4.7. Comparison of five methods in detecting gastrointestinal parasites of pigs

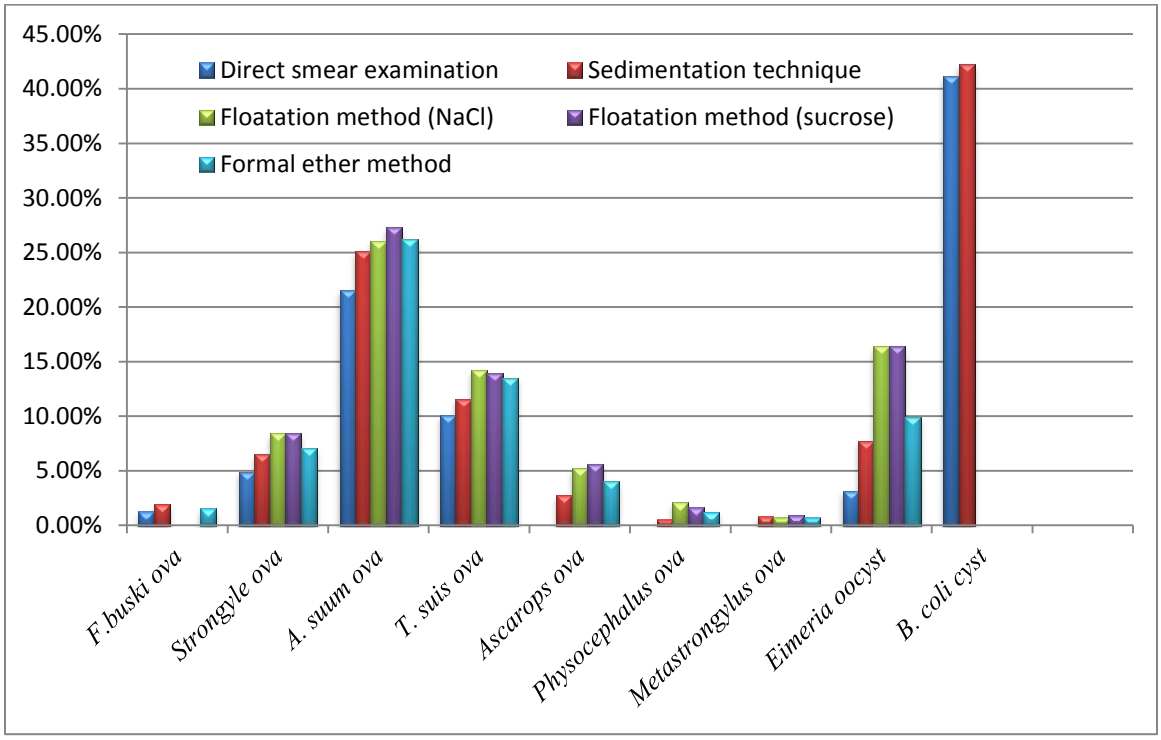


Fig. 4.8. Gastrointestinal parasites recovered from the GIT of pigs

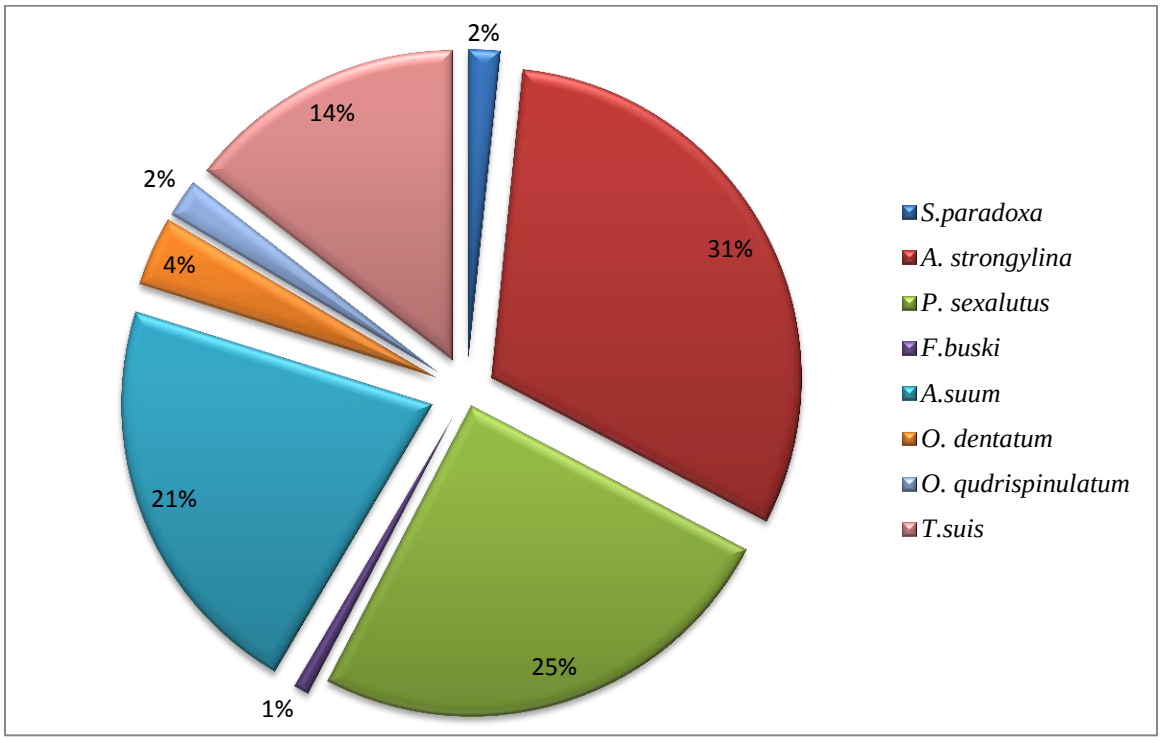
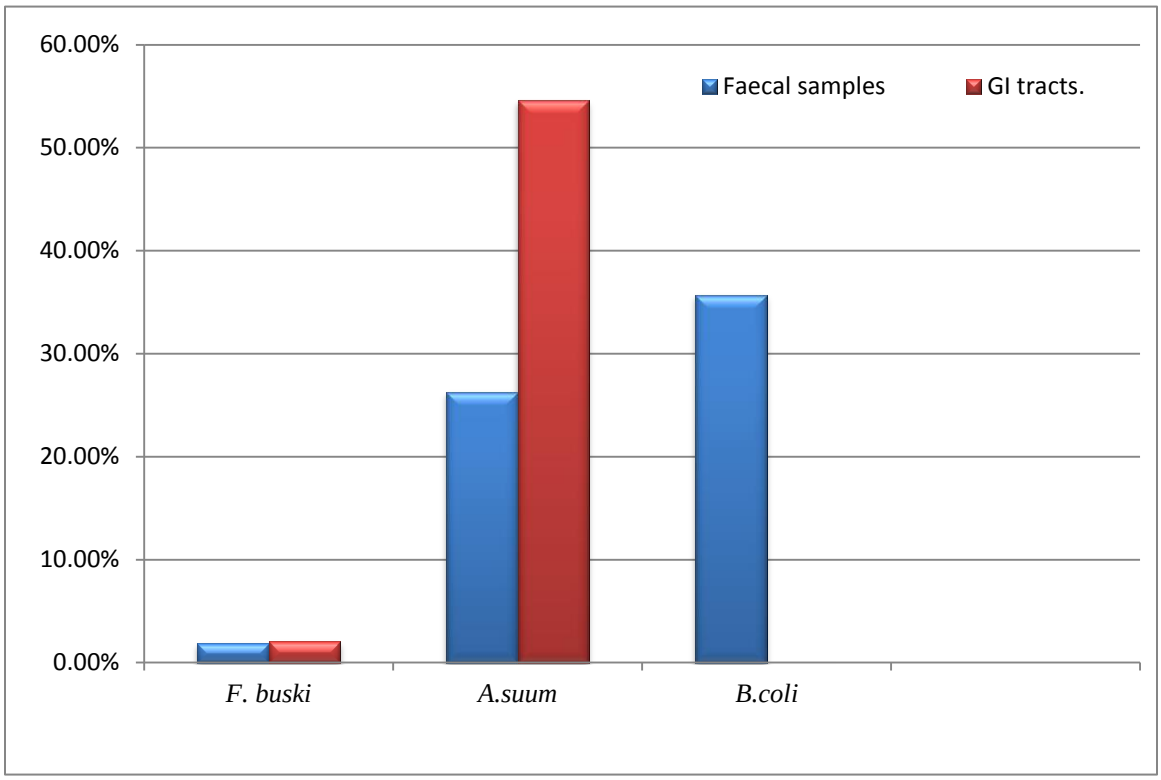


Fig. 4.9. Prevalence of zoonotic important G I parasites



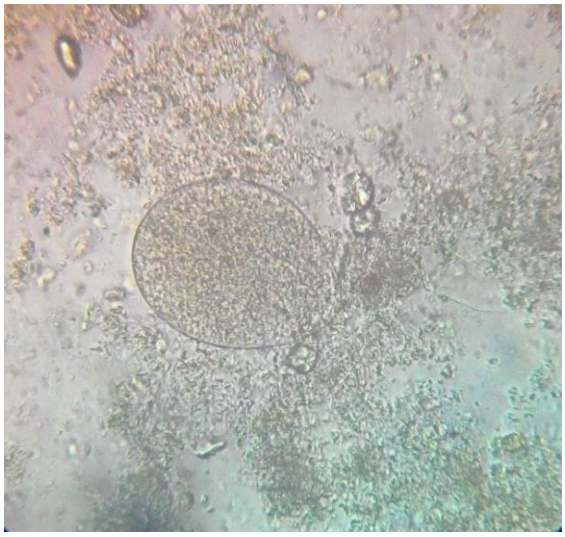


Plate 4.1. Operculated egg of *F.buski* in faecal sample (40X)

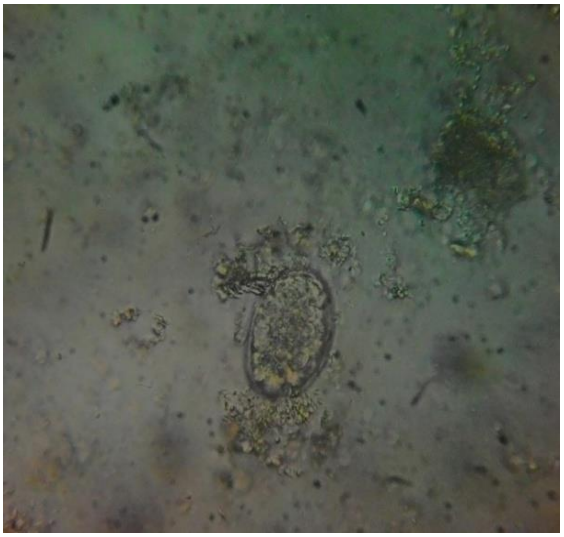


Plate 4.2. Strongyle egg with thin shell and segmented yolk

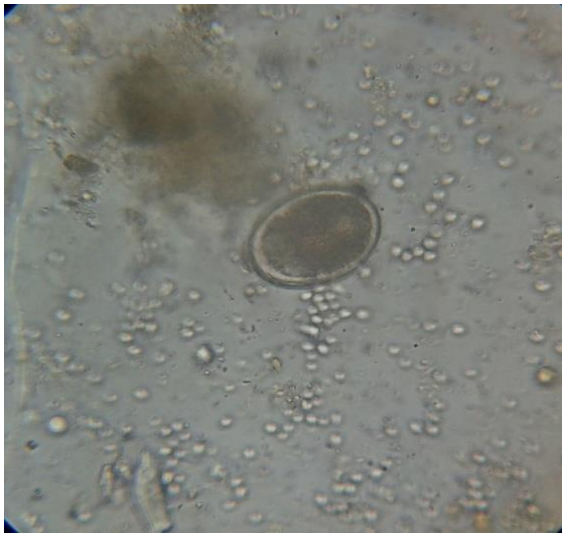


Plate 4.3. *A. suum* egg without Mammilations on outer wall (unembryonated) (40X)

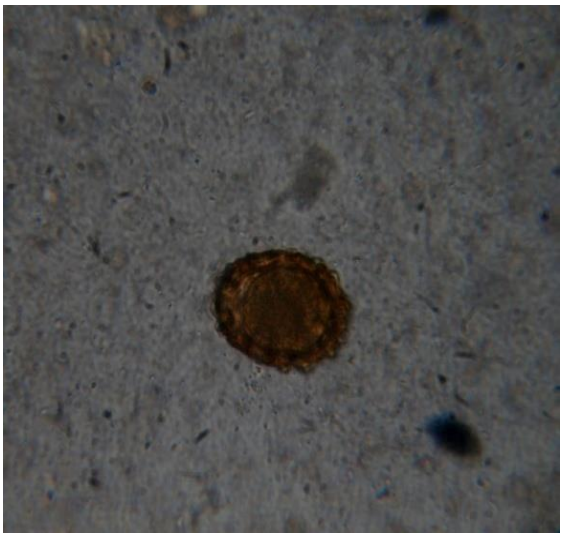


Plate 4.4. *A. suum* with mammilation (embryonated) (40X)

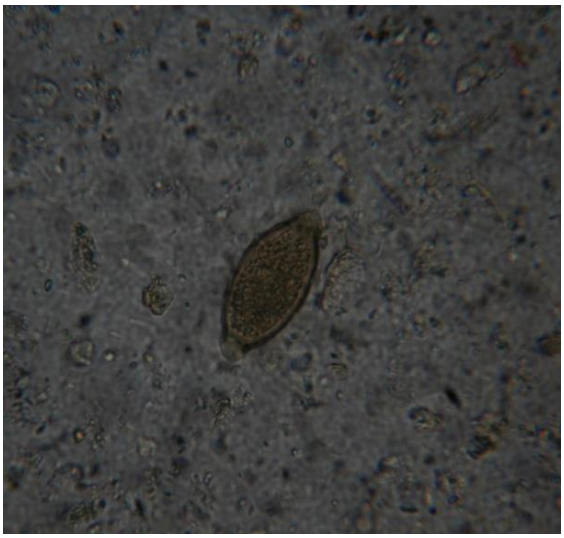


Plate 4.5. *Trichuris suis* egg, barrel shape with transparent plugs (40X)

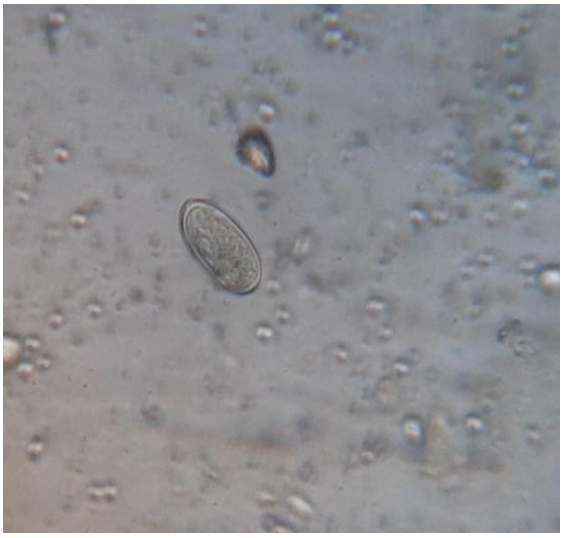


Plate 4.6. *Ascarops sp.* eggs with thick shells surrounded by thin membrane with irregular outline (40X)

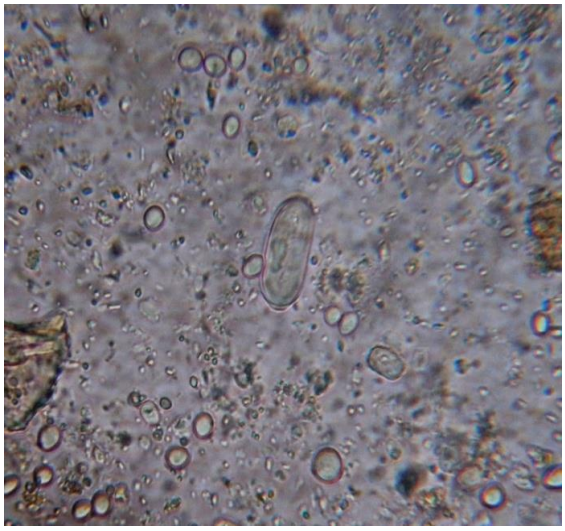


Plate 4.7. *Physocephalus sp.* eggs with thick shells, contain larvae inside (40X)

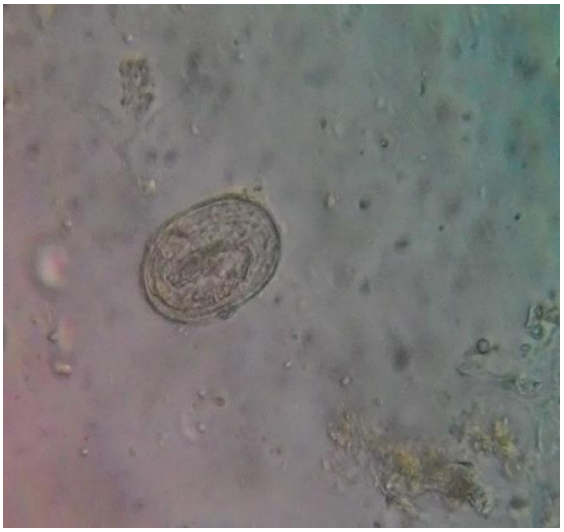


Plate 4.8. *Metastrongylus sp*. egg with developing larvae (40X)

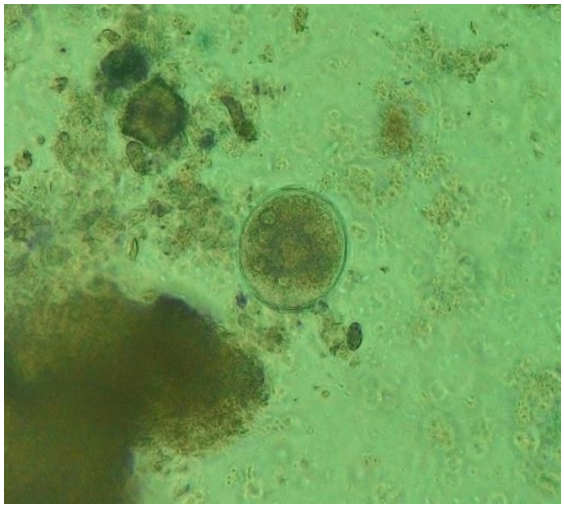


Plate 4.9. *B.coli* cyst oval shape with numerous food vacuoles (40X)

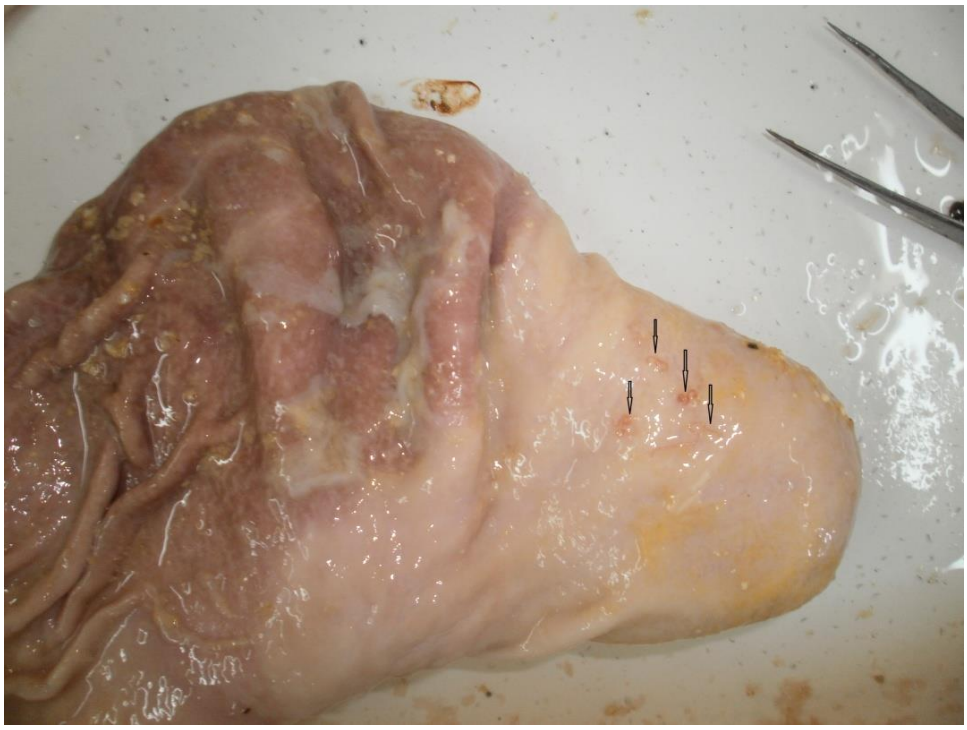


Plate 4.10. Inverted stomach showing the embedded spirurid worms on mucosa

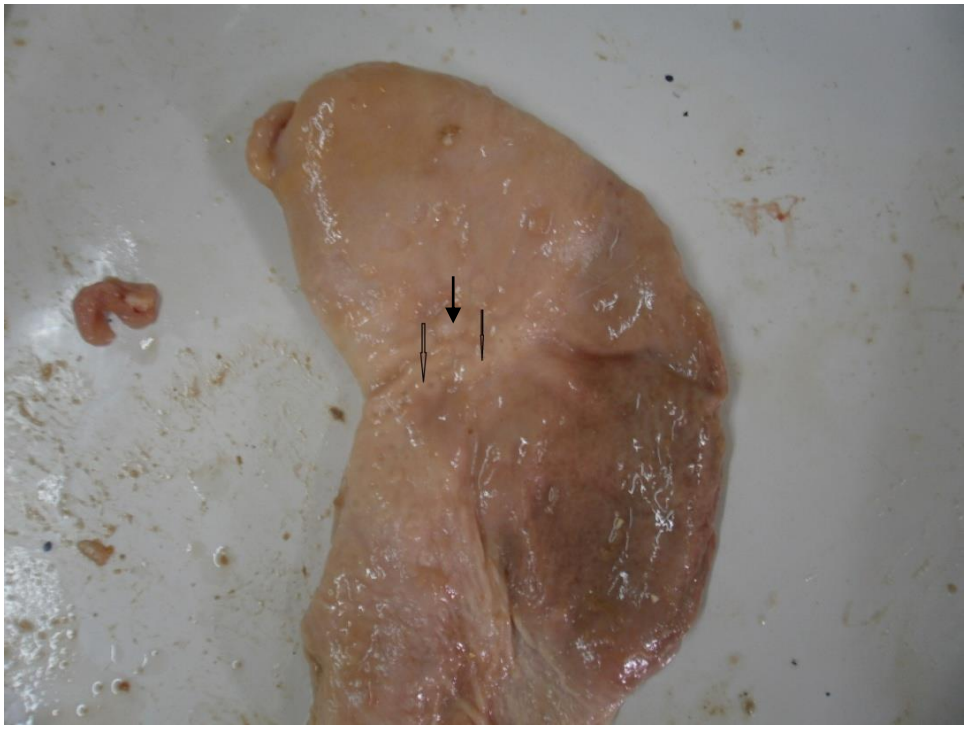


Plate 4.11. Cyst of *Simondsia paradoxa* on the stomach wall

Plate 4.12. Mass of adult *A. suum* in small intestine on incision

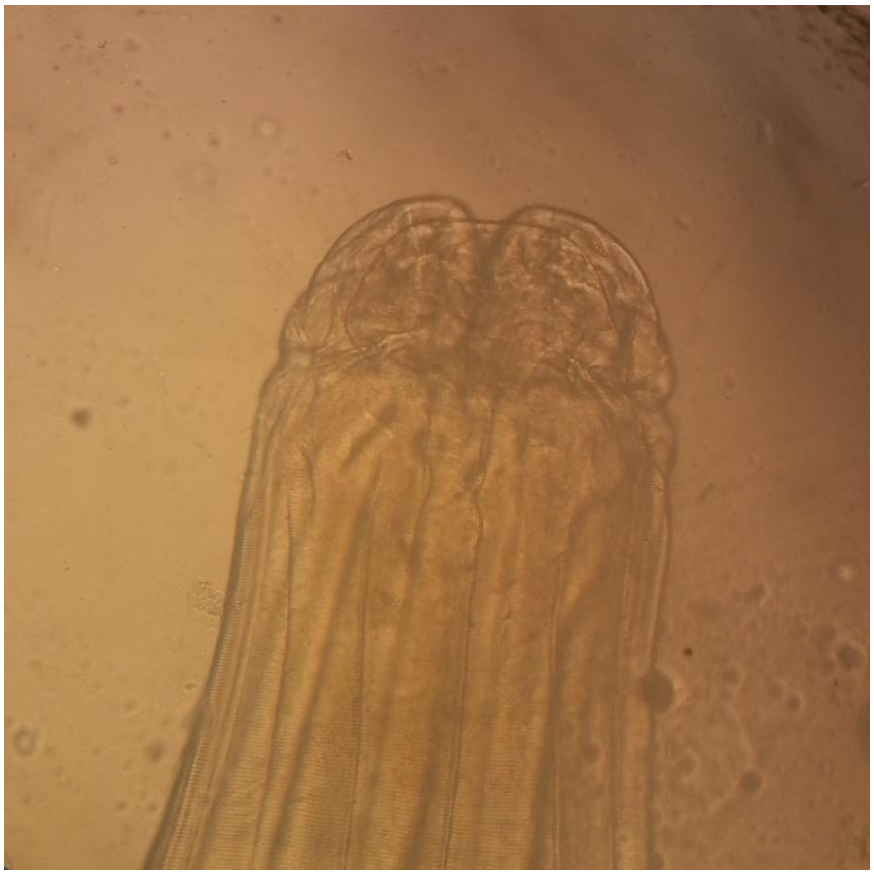


Plate 4.13. Anterior end of *A.suum* showing trilobed lips

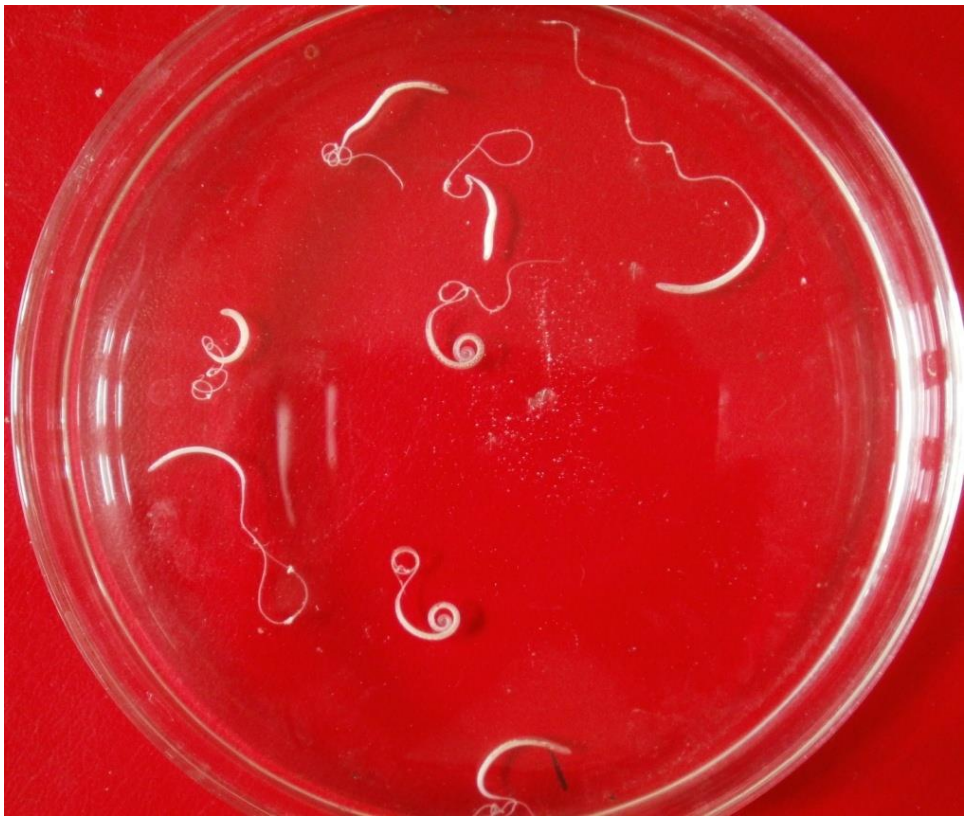


Plate 4.14. Adult *Trichuris suis* worm recovered from large intestine

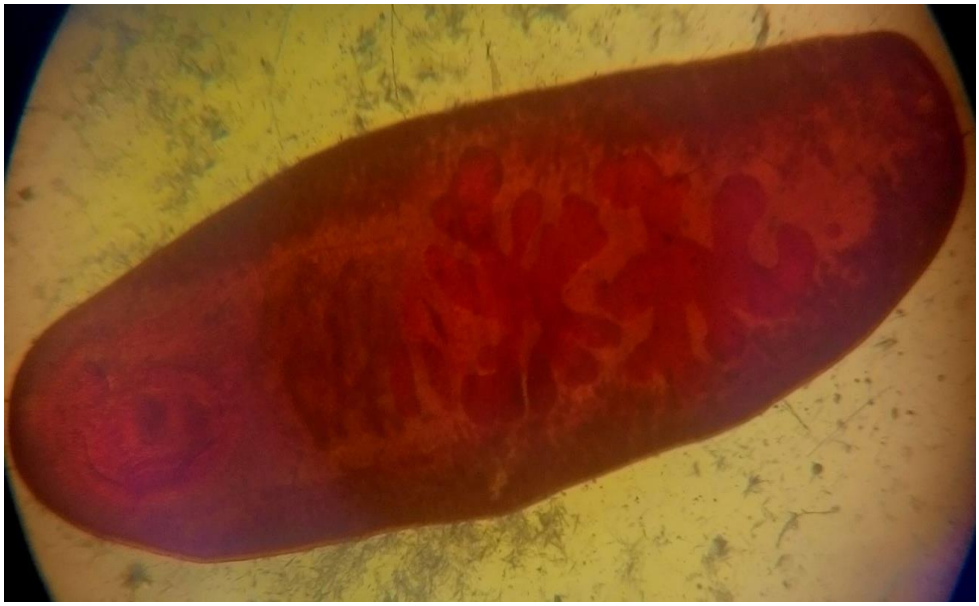


Plate 4.15. *F. buski* unbranched caeca which reach almost posterior

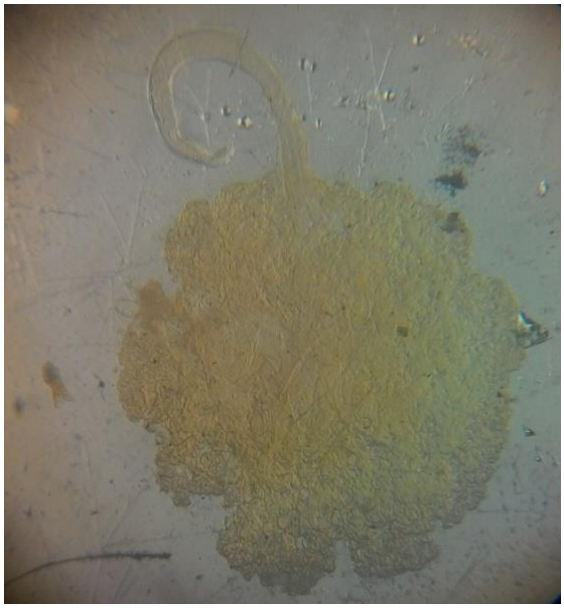


Plate 4.16. *S. paradoxa* female worm with globular shape and posterior end filled with eggs (4X)

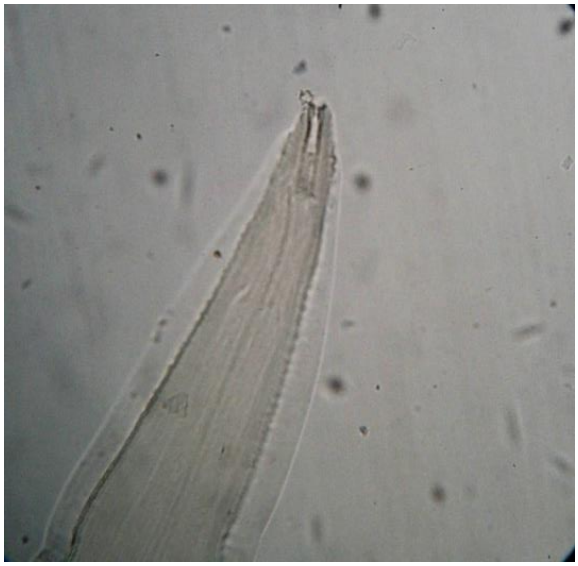


Plate 4.17. Anterior end of male *S. paradoxa* (40X)

Plate 4.18. Posterior end of male *S. paradoxa* spirally coiled, posterior end with unequal spicules (40X)

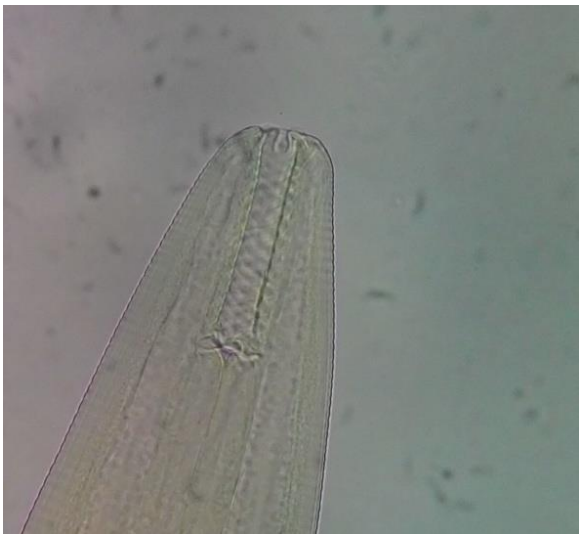


Plate 4.19. Anterior end of *A. stongylina* pharynx strengthened by spiral thickening (40X)

Plate 4.20. Posterior end of *A. stongylina* showing two unequal spicules left spicule is longer than right one (40X)

Plate 4.21. Anterior end of *P. sexalutus* pharynx wall were strengthened by a single spiral thickening which break up into complete rings in the middle portion (40X)

Plate 4.22. *O. dentatum* oesophagus is club shaped and not swollen at anterior end (40X)

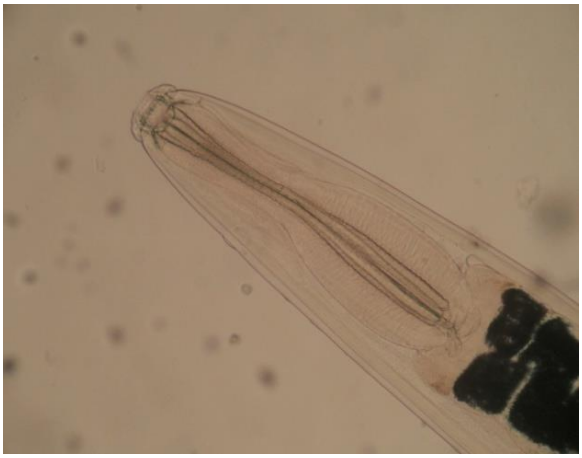


Plate 4.23. *O.qudrispinulatum* oesophagus is vase shaped, swollen at anterior end (40X)

Plate 4.24. *O. qudrispinulatum* posterior end of male the bursa is well developed with two equal spicules (40X)

Plate 4.25a. Faecal sample kept in petridish for larval culture

Plate 4.25b. Baermann's apparatus, for recovery of larvae

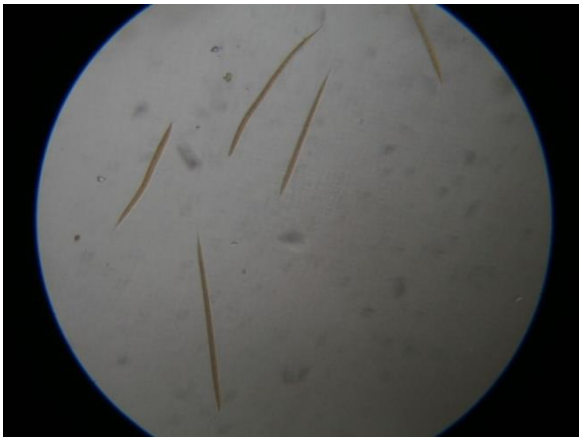


Plate 4.25c. L_3 stage larvae (10X)

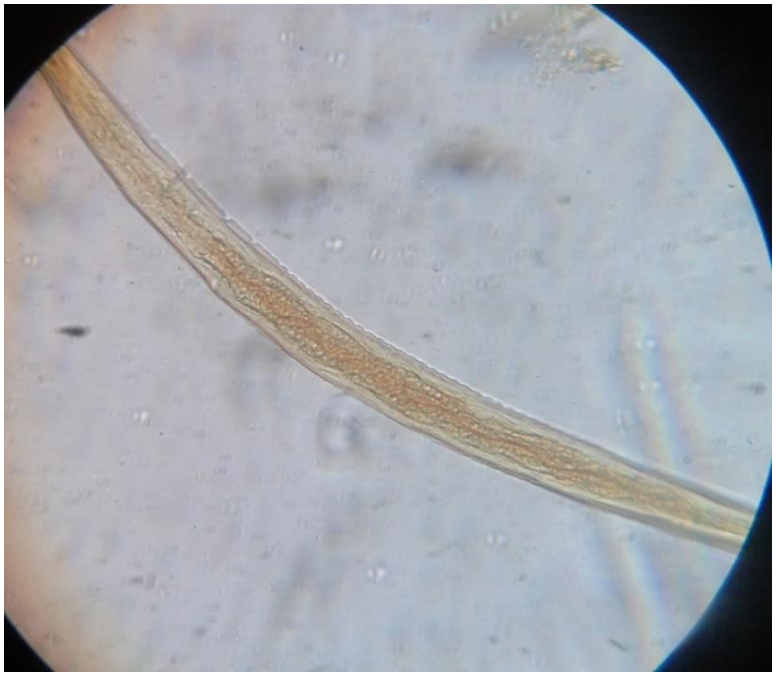


Plate 4.26. *Oesophagostomum* larvae with triangular intestinal cells (40X)

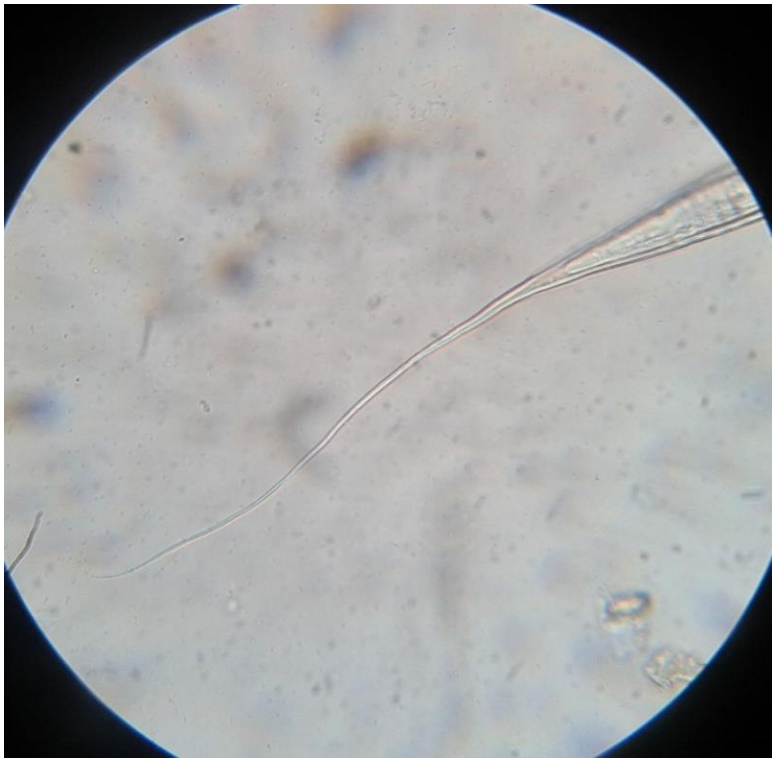


Plate 4.27. Posterior end of *Oesophagostomum* larvae showing long and filamentous tail sheath (40X)

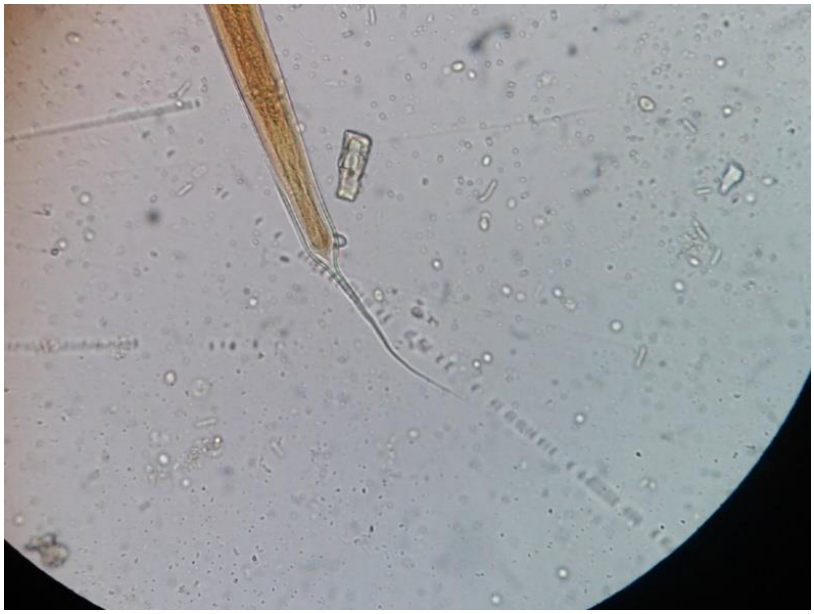


Plate 4.28. Posterior end of *Hyostrongylus rubidus*larvae with digitiform process with short tail sheath (40X)

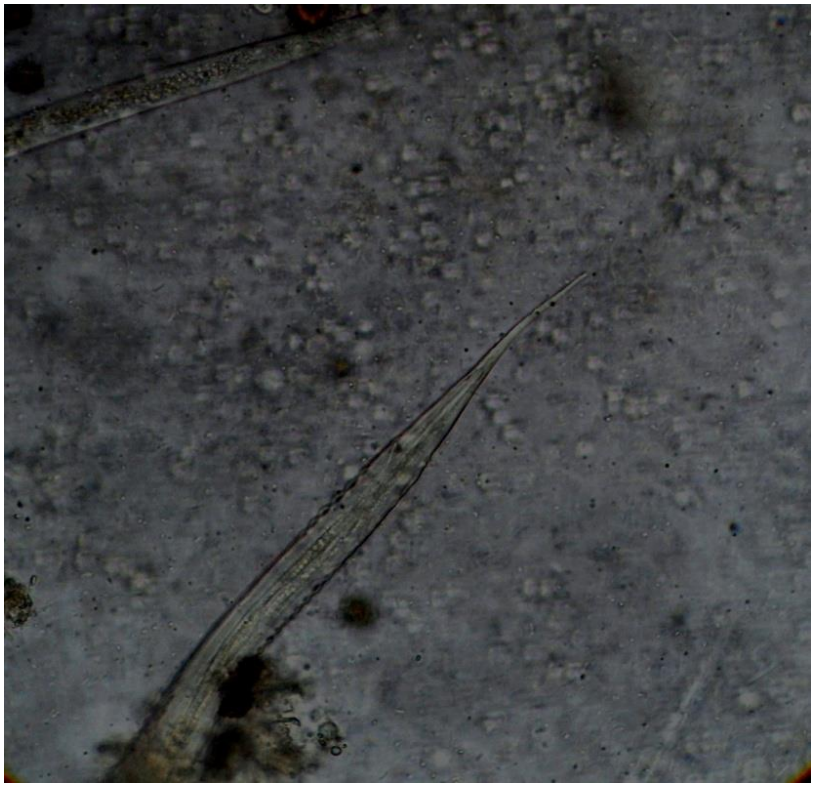


Plate 4.29. Posterior end of *Trichostrongylus* larvae ending with short tail sheath (40X)

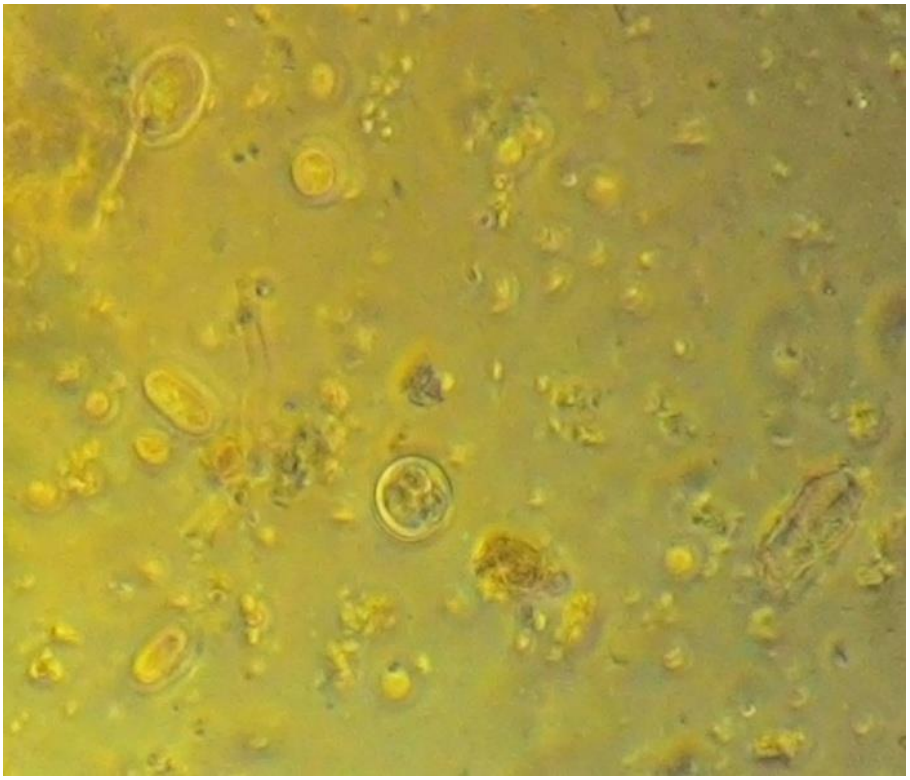


Plate 4.30. Sporulated oocyst of *E. preminuta* (40X)

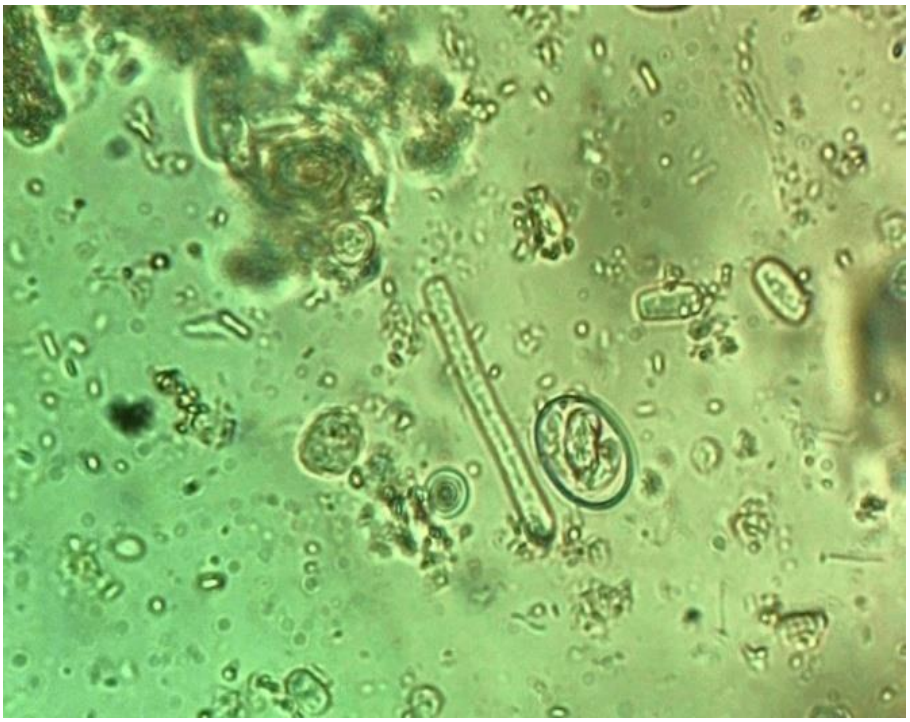


Plate 4.31. Sporulated oocyst of *E. debliecki* (40X)

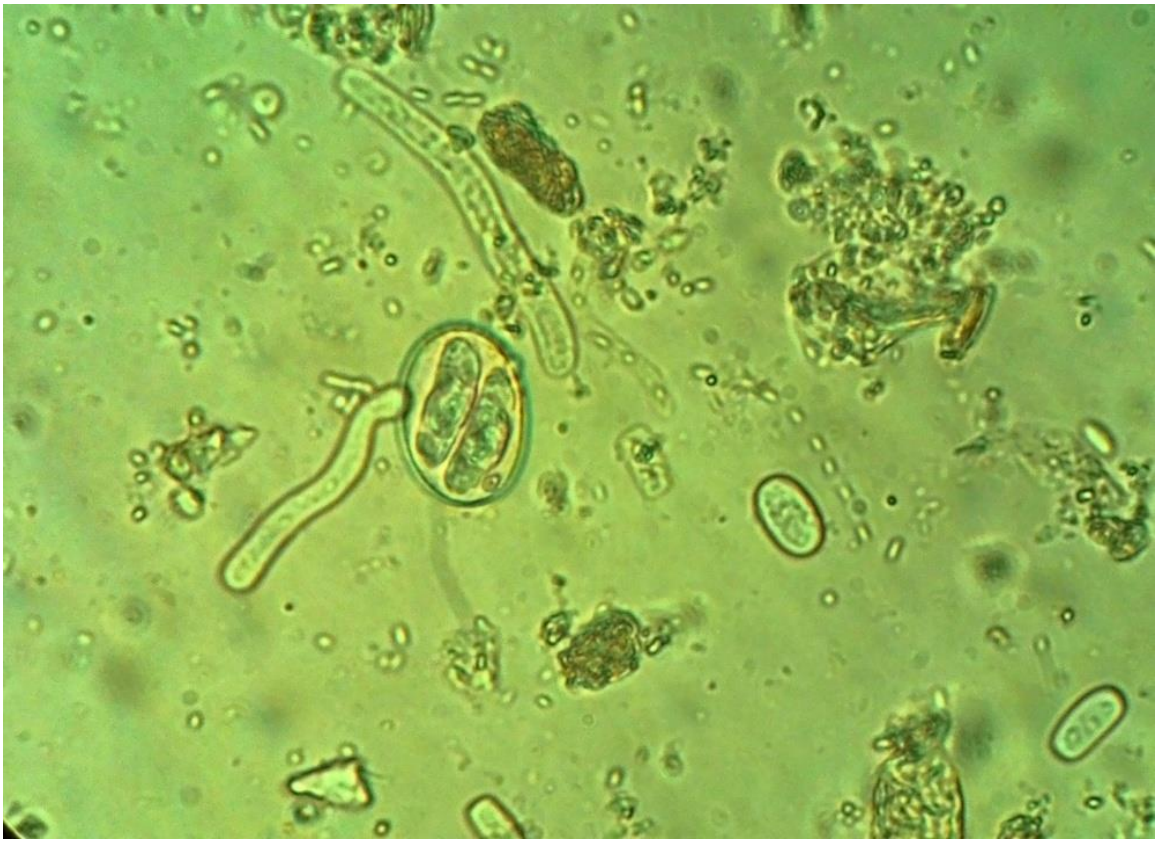


Plate 4.32. Sporulated oocyst of *E. scabra* (40X)

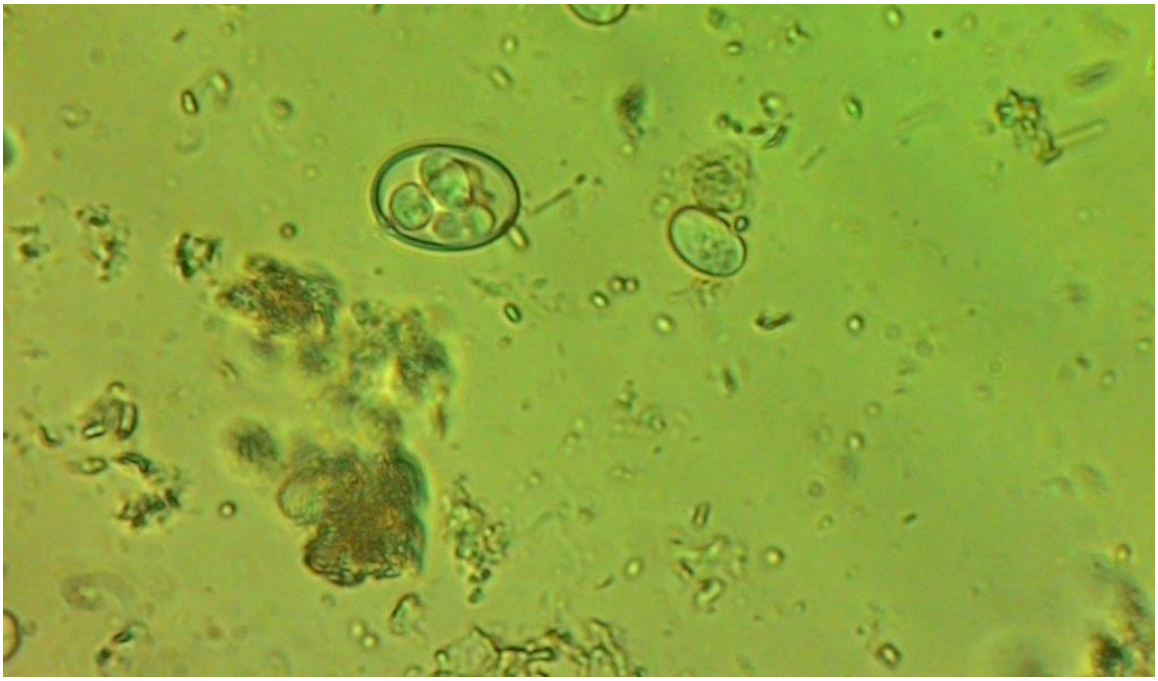


Plate 4.33. Sporulated oocyst of *E. suis* (40X)

Discussion

V. DISCUSSION

In the swine industry parasitic infection is associated with severe economic losses due to decreased litter size, poor growth rate, reduced weight gain, condemnation of visceral organs at slaughter and mortality in young piglets (Stewart and Hale, 1988).

Several workers have reported the prevalence of gastrointestinal parasites in pigs from various countries like Ghana (Permin, *et al.*, 1999), West Indies (Tiwari, *et al.*, 2009), Japan (Matsubayashi, *et al.*, 2009), Korea (Ismail, *et al.*, 2010), Nigeria (Sowemimo, *et al.*, 2012), Bangladesh (Dey, *et al.*, 2014).

In India, the prevalence of gastrointestinal parasites in pigs have been reported by several workers from Delhi (Singh, 1959), Madras (Alwar, 1958 and Misra, *et al.*, 1972), Andra Pradesh (Rao, 1966), Madhya Pradesh (Shrivastav and shah, 1968 ; Agrawal, *et al.*, 2004), Assam (Sarma and Gogoi, 1986), Uttar Pradesh (Chandra, 1984; Rout and Saikumar, 2014), Meghalaya (Rajkhowa, 1996 and Laha *et al.*, 2014), Jarkhand (Kumar, *et al.*, 2002 ; Bauri *et al.*, 2012), West Bengal (Dutta, *et al.*, 2005), Jammu (Khajuria, *et al.*, 2010).

In Karnataka, the prevalence of gastrointestinal parasites in pigs was reported from Shimoga (Murthy, *et al.*, 2014). There was no detailed study in other regions hence the present study was attempted to know the prevalence of gastrointestinal parasites in different managemental systems and also to know the status of zoonotically important gastrointestinal parasites of pigs in this region.

5.1. Prevalence of gastrointestinal parasites of pigs in different managemental systems by faecal examination

In the present study the overall prevalence of gastrointestinal parasites was found to be 73.7 per cent. *Balantidium coli* (35.7%) was the most prevalent gastrointestinal parasite followed by *Ascaris suum* (26.3%), *Eimeria* oocyst (15.7 %), *Trichuris suis* (14.2 %), Strongyles (7.31 %), *Ascarops sp*. (4.9 %), *Physocephalus sp*. (2.06 %), *Fasiolopsis buski* (1.9 %) and *Metastrongylus sp*. (0.9 %) which was in agreement with findings of Kumar *et al.* (2002) they reported overall prevalence of 71.92 per cent from Ranchi, India.

Khajuria *et al.* (2010) in India recorded higher infection of 80.64 per cent and reported *Ascaris sp., Trichuris sp.,* strongyle, *Strongyloides sp.* and oocysts of Eimeria. Whereas Godara and Sharma (2010) in India recorded lower prevalence of 26.6 per cent and recorded *Ascaris sp. Strongyloides sp. Eimeria sp. B.coli* and *Trichuris sp.*

5.1.1. Faecal sample examination of pigs from free range pigs

During this study, the higher prevalence of GI parasites of 91.2 per cent was observed in desi pigs whereas of Murthy *et al.* (2014) from Shimoga region of Karnataka recorded 100 per cent prevalence of G I parasites in desi pigs. The higher prevalence during this study could be probably due to grazing of pigs in free ranging system which may get easy access to the infective stages of parasites and deworming were not done.

In contrast to present study, Borthakur *et al.* (2007) from of Aizawl district of Mizoram reported lower prevalence of 37.5 per cent of G I parasitic infections in pigs

reared under indigenous managemental system. The lower prevalence recorded by Borthakur *et al.* (2007) may be probably due to the collection of samples from the pig farms which were constructed with bamboo and raised platforms of about 2-3 feet from the ground. Most of the pigs were stall fed hence pigs had less access for infective stages of parasites.

5.1.2. Faecal sample examination of pigs from Government organized farms

In the present study the prevalence of 68.1 per cent in Government organized farms was recorded which is in contrast with the findings of Murthy *et al.* (2014) who recorded prevalence of 38.0 per cent in Government organized farm from Shimoga region of Karnataka. Even though deworming schedules are maintained in Government farms pig sheds were constructed head to head type in which pigs may have easy access for drainage channels. Dept. of ILFC piggery unit Veterinary college, Bangalore, the piggery units were maintained under semi intensive managmental system.

5.1.3. Faecal sample examination of pigs from Private organized farms

In this study, the prevalence of 66.8 per cent was recorded in Private organized farms, however, Murthy *et al.* (2014) recorded lower prevalence of 56.0 per cent in Private farm and from Shimoga region of Karnataka. Godara and Sharma (2010) also reported the lower prevalence of 26.6 per cent parasitic infections in pigs from organized farms of Jaipur. Higher prevalence in present study may be attributed to pigs maintained on stone or concrete floors and cleaning was done once in two days in Private farms and also pig sheds were constructed head to head type in which pigs may have easy access for drainage channels.

5.2. Age wise prevalence of gastrointestinal parasites of pigs

Gastrointestinal parasites was found to be higher in age group of 0-6 months followed by 6 months - 2 yrs and above 2 yrs. *F. buski* infection was higher in older pigs above 2yrs than younger ones (0-6 months) whereas *Eimeria* and *B.coli* infection was found to be higher in young animals (0-6months) than older ones. The present findings are in agreement with Khajuria *et al.* (2010) who also reported trematode infection was higher in older pigs than younger ones and protozoan infection in younger age group.

Coccidiosis of pigs is primarily a disease of young piglets and older pigs act as carriers. The higher prevalence of coccidian parasites in young piglets during this study could be probably due to inadequate disinfection of farrowing pens. However, *B. coli* infection was also found to be common in young piglets because cysts are the source of infection and they remain viable for days or weeks in moist pig faeces (Soulsby, 2005).

In the present study, the rate of mixed infection with more than one species of parasites was found to be 51.0 per cent. Whereas Khajuria *et al.* (2010) recorded 41.61 per cent of mixed infection in pigs at Jammu district and Borthakur *et al.* (2007) recorded 66.0 per cent of mixed infection in pigs at Aizwal. In the present study, the mixed infections were higher in young animals (0-6 months) compared to adults (>2yrs) may be probably due to inadequate disinfection of farrowing pens.

5.3. Quantitative estimation of strongyle ova

In present the study, average mean egg count of strongyle ova in pigs was 1304.03±349.72 with a range of 167-5500 EPG. In contrast to the present study, lower

EPG count of Mean± SE 142. 9±13.7 was recorded by Dey *et al.* (2014) in Bangladesh and ranged from 100-200.The difference in EPG count of Strongyle eggs in the present study could be probably due to prevailing agro climatic conditions favourable for survival of eggs in the environment and faecal samples were collected from pigs maintained in both organized and unorganized farms under different managemental practices. However, higher EPG counts were recorded in desi pigs which could be due to its scavenging habit.

5.4. Third stage larvae of different strongyle species obtained from faecal culture of pigs

The coproculture studies revealed the prevalence of larvae of *Oesophagostomum* sp. (100%), *Trichostrongylus sp.*(11.32%) and *Hyostrongylus rubidus* (3.77%). The similar finding with *Oesophagostomum* larvae (100%) were reported by Roepstorff *et al.* (1998) and Eijck and Borgstede (2005) in abroad, however *Trichostrongylus* larvae and *Hyostrongylus rubidus* larvae was not recorded. In contrast to the present study, Martin *et al.* (1974) Canada recorded 78.5 and 50.0 per cent of *Oesophagostomum* larvae and *Hyostrongylus rubidus* larvae respectively. The variation in the recovery of 3rd stage larvae of different strongyles may be due to survivability of eggs in the soil with different agro climatic conditions.

5.5. Quantitative estimation of *Eimeria* oocysts

In present the study, the average mean oocysts count of *Eimeria* sp. in pigs was 5348.64±767.56 with a range of 734-25536 OPG. However, Dey *et al.* (2014) from Bangladesh recorded mean OPG count 1527±287.8 and ranged from 100-10800. Whereas Karamon *et al.* (2007) from Poland recorded higher OPG count of 5748.5. The

difference in the OPG counts during this study may be due to difference in the climatic conditions required for the for survival of oocysts.

5.6. Prevalence of different species of *Eimeria* in pigs

Four species of *Eimeria* oocysts were recorded in the present study namely *E. perminuta, E. suis, E. debliecki* and *E. scabra*. Karamon *et al.* (2007) from Poland recorded similar species of *Eimeria* oocysts, whereas Misra *et al.* (1972) from India reported *E. perminuta, E. debliecki* and *E. scabra.* Matsubayashi *et al.* (2009) reported only *E. suis* and *E. scabra* from Japan.

5.7. Comparison of five methods in detecting gastrointestinal parasites in pigs

Among the five different tests employed in screening of faecal samples from pigs, sedimentation technique was found to be highly sensitive in detecting *F. buski* ova and cysts of *B. coli*. Similarly, flotation technique with saturated Nacl and sucrose was found to be highly sensitive in detecting *Eimeria* oocysts and nematode eggs. The present findings are in agreement with Kaufmann (1996).

5.8. Examination of gastrointestinal tracts of pigs

Out of 97 gastrointestinal tracts of pigs examined, 85 (87.62%) were found to be positive for adult parasites. *Ascarops strongylina* (79.38%) was found to be predominant followed by *Physocephalus sexalatus* (63.91%), *Ascaris suum* (54.63%), *Trichuris suis* (37.11%), *Oesophagostomum dentatum* (9.27%), *O. quadrispinulatum* (5.15%), *Simondsia paradoxa* (4.12%) and *Fasciolopsis buski* (2.06%).

Gastrointestinal parasites recorded in the present study were also reported by several workers viz., Alwar (1958), Rao (1966), Shrivastav and Shah (1968) and Misra *et al.* (1972) in India.

Findings of *A. strongylina* and *P. sexalatus* were in close agreement with the report of Permin *et al.* (1999) from Ghana who recorded 76.7 and 65.0 per cent respectively. Whereas the higher prevalence rate of 63.3 and 38.3 per cent of *O. dentatum* and *O. quadrispinulatum* adult parasites were recorded respectively.

The finding of *S. paradoxa* in the present study was found to be 5.5 per cent which is in agreement with Shrivastav and Shah (1968) from Madhya Pradesh (India). However, they also recorded higher prevalence of *O. dentatum* (50%) and *A. strongylina* (87%) and lower prevalence of *Ascaris* (14.8%), *Trichuris* (18.5%) and *P. sexalatus* (31.3%).

In contrast to present study, the higher prevalence of *A. suum* (65%), *T. suis* (60%), *F. buski* (55%) were reported by Dey *et al.* (2014) from Bangladesh. Nganga *et al.* (2008) from Kenya also reported higher prevalence of *O. dentatum* (39.1%) and *O. quadrispinulatum* (14.8%) but the prevalence of *T. suis* (32.2%), *A. suum* (28.7%), *A. strongylina* (1.7%) and *P. sexalatus* (0.9%) was found to be lower. However, D'Souza *et al.* (2001) from Karnataka and Sadarao *et al.* (2011) from Patna recorded higher prevalence rate of 10.0 and 46.59 per cent of *F. buski* respectively.

In the present study, the prevalence of *A. strongylina* and *P. sexalatus* were highest in slaughtered pigs. Since, they had easy access for beetles due to their rooting

habit. The lower prevalence of *F. buski* infection during this study could be probably due to reduction in breeding habitat of snails in the urbanized areas.

During this study the prevalence of gastrointestinal parasites in faecal samples was relatively low compared to gross examination of GIT of pigs. Which may be probably due to, excretion of ova/oocysts depending on the several factors namely host factors (age, sex, nutrition and immune status), parasitic factor (sexual maturity of worms) and environmental factors (temperature, humidity and season).

5.9. Prevalence of zoonotic gastrointestinal parasites

In the present study, three parasites of zoonotic importance were recorded which included *A. suum, F. buski* and *B. coli*. All the three parasites were recorded from all the three managemental system. The farm workers who were close association with the farm activities are at risk.

Fasciolopsis is one of the important zoonotic trematode infections shared by man and domestic pigs. Pigs act as the key host and which serves as the reservoir for transmission of infection to man (Parija, 1990). Fasciolopsiosis in India has been reported from Assam, West Bengal, Arunachal Pradesh, Nagaland, Meghalaya, Mizoram, Tripura, Bihar and Uttar Pradesh. A survey conducted in six villages of Uttar Pradesh revealed 22.4 per cent of persons were infected with *F. buski* (Chandra, 1984). During this present study the prevalence of *F. buski* in faecal samples of desi pigs was 1.9 per cent which will act as source of infection to human beings through the contamination of soil and water bodies.

A. suum female can lay up to 200 000 eggs per day and the eggs are very resistant for external environmental temperature and can survive even up to 5 yrs (Soulsby, 2005). *A. suum* in humans and pigs seems to represent two different species but cross infection may occur (Betson., *et* al., 2011). *A.suum* was predominant among desi pigs which will contribute to contaminations of soil with eggs.

B.coli is a common ciliate which is cosmopolitan in distribution and found mostly in pigs. Balantidiosis occur in population living in hot and humid climate and in close association with pigs. It causes balantidial dysentery in humans (Parija, 1990). Cysts are the source of infection and they remain viable for days or weeks in moist pig faeces. Humans get the infection from swine through contamination of foodstuffs with cysts. (Soulsby, 2005).

Summary

VI. SUMMARY

The present study was designed to know the prevalence of gastrointestinal parasites of pigs in Government organized farms, Private organized farms and pigs reared on free range system with the following objectives.

- To compare the occurrence of parasites in both live and slaughtered pigs.
- To know the zoonotic importance of parasites in pigs.

The faecal samples were subjected to different parasitological techniques by direct smear examination, sedimentation technique, flotation technique and formal ether method. The common strongyles of pigs were identified based on coproculture. Parasitic load of eggs and oocysts were estimated by Mc Master technique.

Out of 725 faecal samples collected, 320 were from Private organized farm, 210 from Government organized farm and 195 from unorganized farm. The overall prevalence rate recorded for gastrointestinal parasites in pigs was 73.7 per cent. *B. coli* cyst (35.7%) was recorded maximum followed by *Ascaris suum* ova (26.3%), *Eimeria sp.* oocyst (15.7%), *Trichuris suis* (14.2%), Strongyle (7.31%), *Ascarops sp*. (4.9%), *Physocephalus sp*. (2.06%), *Fasciolopsis buski* (1.9%) and *Metastrongylus sp*. ova (0.9%). The mixed infections were common, especially with *B. coli*, *Eimeria sp.* and *A. suum* ova.

In the present study, the prevalence rate of gastrointestinal parasites was found to be highest in free range pigs (91.2%) followed by Government organized farms (68.1 %) and Private organized farms (66.8 %).

Among free range pigs *A. suum* infection (57.4%) was found to be highest followed by *B. coli* (35.4 %), *T. suis* (31.79%), *Eimeria sp.* (21%), Strongyles (18.9%), *Ascarops sp*. (18.4 %) *Physocephalus sp*. (7.6%), *F. buski* (4.6%) and *Metastrongylus sp.* (2.0%).

In Government organized farms, *B. coli* infection (46.6 %) found to be highest followed by *A. suum* (19.5 %), *Eimeria sp.* (7.6 %), *T. suis* (4.7 %), Strongyles (3.3 %), *F. buski* (0.9 %) and *Metastrongylus sp.* (1.4 %) .

B. coli infection (30.6 %) was found to be more prevalent in Private organized farm followed by *Eimeria sp.* (17.8 %), *A. suum* (11.8 %), *T. suis* (9.6 %), Strongyles (2.8 %), *F. buski* (0.9 %).

In the present study, prevalence of parasites is higher in age group of 0-6months (83.33%) followed by 6months- 2yrs (72.3%) and above 2yr (70.6%). Among 0-6months age groups of pigs, *B.coli* infection (52%) was found to be highest followed by *Eimeria sp.* (27.33%), *T. suis* (22%), *A.suum* (18.66%) and Strongyles (9.33%).

B. coli infection (34.2%) was found to be the highest among age groups of 6months-2yrs followed by *A. suum* (27.6%), *Eimeria sp.* (13.8%), *T. suis* (11.4%), Strongyles (8.5%), *Ascarops sp.*(5.2%) and *F. buski* (0.9%).

Among age groups above 2yrs, *B.coli* infection (29.04%) was found to be highest followed by *A.suum* (28.7%), *T. suis* (12.6%), *Eimeria sp.* (12.05%), Strongyles (6.03%) *Ascarops sp.* (6.84%), *Physocephalus sp*. (4.1%), *F. buski* (3.2%) and *Metastrongylus sp*. (1.91%).

The average mean egg count of Strongyle ova in pigs was 1304.03±349.72 with a range of 167-5500 EPG. The overall mean EPG count Private organized farm was 433.33±123.6 with a range between 100-1200 whereas in Government organized farm, the EPG count was 1057.14±477.56 with a range between 100-3800 and in unorganized farm EPG count was 2421.62±448.02 with a range of 300-11500.

The coproculture studies revealed the highest prevalence of *Oesophagostomum* larvae (100 %) followed by *Trichostrongylus* larvae (11.32 %) and *Hyostrongylus* larvae (3.77 %)

The average mean oocyst count of *Eimeria* oocyst in pigs was 5348.64±767.56 with a range of 734-25536 OPG. The overall mean OPG count for Private organized farm was 5756.14±1051.85 with a range from 400-45300, Government organized farm the OPG count was 3606.87±530.6 with a range between 600-6800 and in unorganized farm OPG count was 6682.92±720.24 with a range of 1200-24500.

Four species of *Eimeria* were recorded. *E. debliecki* (86.84 %) was found to be highest followed by *E. suis* (71.05 %), *E. scabra* (61.40 %) and *E. perminuta* (40.3 %).

Among the five different qualitative test employed the sensitivity of sedimentation method was higher in detecting *B. coli* cysts in pigs. Analysis of data by analysis of variance (ANOVA) revealed a significant difference between the tests in the detection of gastrointestinal parasites ($P \leq 0.05$).

Out of the 97 GIT examined, 85 (87.62 %) were found positive for adult parasites. *Ascarops strongylina* (79.38 %) was predominant followed by *Physocephalus sexalatus*

(63.91 %), *Ascaris suum* (54. 63 %), *Trichuris suis* (37.11 %), *Oesophagostomum dentatum* (9.27 %), *O. quadrispinulatum* (5.15 %), *Simondsia paradoxa* (4.12 %) and *Fasciolopsis buski* (2.06 %). This happened to be first report of *A. strongylina*, *P. sexalatus* and *S. paradoxa* from pigs in Karnataka state.

In the present study, *A. suum* (26.3 %), *F. buski* (1.9 %) and *B. coli* (35.7 %) were the three zoonotic important GI parasites recorded in faecal sample examination and *F. buski* (2.06 %), *A. suum* (54.63 %) were recorded from GI tract examination.

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Abstract

VIII. ABSTRACT

A study on prevalence of gastrointestinal parasites of pigs was undertaken to know the prevalence of gastrointestinal parasites of pigs of Government organized farms, Private organized farms and free range reared pigs. Examination of faecal samples revealed a higher prevalence rate of 73.7 per cent of gastrointestinal parasites in pigs. Among them *B. coli* cyst (35.7%) was recorded maximum followed by *Ascaris suum* (26.3%), for *Eimeria* oocyst (15.7%), *Trichuris suis* (14.2%), strongyle (7.31%), *Ascarops sp*. (4.9%), *Physocephalus sp*. (2.06%), *Fasciolopsis buski* (1.9%) and *Metastrongylus sp*. (0.9%). In the present study, the prevalence of parasites was maximum in age group of 0-6months (83.33%) followed by 6months- 2yrs (72.3%) and above 2yr (70.6%). Prevalence rate of GI parasites was found to be highest in free range pigs (91.2%) followed by Government organized farms (68.1 %) and Private organized farms (66.8 %). The average mean EPG of strongyle ova in pigs were 1304.03±349.72 with a range of 167-5500. The coproculture studies revealed the higher prevalence of *Oesophagostomum* larvae (100 %) followed by *Trichostrongylus* larvae (11.32 %) and *Hyostrongylus* larvae (3.77 %). The average mean OPG of *Eimeria* oocyst in pigs was 5348.64±767.56 with a range of 734-25536. Four species of *Eimeria* were recorded. *E. debliecki* (86.84 %) was highest followed by *E. suis* (71.05 %), *E. scabra* (61.40 %) and *E. perminuta* (40.3 %). Out of 97 GI tracts of pigs examined, 85 (87.62 %) were found positive for adult parasites. *Ascarops strongylina* (79.38 %) was predominant followed by *Physocephalus sexalatus* (63.91 %), *Ascaris suum* (54.63%), *Trichuris suis* (37.11%), *Oesophagostomum dentatum* (9.27%), *O. quadrispinulatum* (5.15 %), *S. paradoxa* (4.12 %) and *F. buski* (2.06 %) were recorded. *A. suum*, *F. buski* and *B. coli.* were the three zoonotic important GI parasites recorded.