CHAPTER # 2

Review of Literature
Coccidiosis is an important parasitic disease of commercial rabbitries and is caused by *Eimeria* species. The disease has significant economic impacts and appears in two forms viz., intestinal and hepatic coccidiosis. Once affected, it remains endemic to a farm and complete elimination warrants stock replacement with complete sterilization of the premises and equipments. Generally the disease which is present in subclinical forms Jeopardises the production potentials. However it takes no time for the disease to flare up clinically in the eventualities of stress or immunosuppression occurring feed borne mycotoxins. The coccidiostats which help in its prevention and control, if not used Judiciously leads to development of resistance further complicating the managerial practices. Various aspects of the disease in light of the available literature are discussed as under:
The occurrence of coccidiosis in rabbits in India was first recorded by Cooper (1927) at Mukteshwar, U.P. Specific identities of these coccidia were, however, not determined by him. Thereafter, Ray (1945) recorded the incidence of *E. stiedai*, *E. perforans*, *E. magna*, *E. media* and *E. irresidua* in rabbits and hares at Mukteshwar, U.P.

Chapman (1948) reported more encouraging results by using Sulphaquinoxaline @ 0.1% in diet.

Pellerdy and Babos (1953) reported that 50,000 oocysts of *Eimeria matsubayashii* and *E. media* were fatal to young rabbits and the lesions included severe enteritis with excessive destruction of the intestinal epithelium. The condition was associated with haemorrhagic diarrhoea. The wall of the caecum was markedly thickened and appeared greyish white in colour due to the accumulation of large number of developmental stages.

Use of Sulphaquinoxaline in feed instead of drinking water @ 1 percent gave best results against rabbit coccidiosis (Lund, 1954).

Pellerdy (1954) found that doses of 50,000 and 1, 00,000 oocysts of *E. neoleporis* produced death in young rabbits by the tenth day of infection. Pathological changes occurred mainly in the region of the ileocaecal valve and in the vermiform appendix. There was thickening of the intestinal wall, which became whitish grey in colour due to the large number of developmental stages. Severe infections produced necrosis of superficial mucosa.

Gill & Ray (1960) reported the incidence of *E. coecicola*, *E. intestinalis*, *E. exigua*, *E. matsubayashii*, *E. neoleporis*, *E. nagpurensis*, *E. stiedai*, *E. perforans*, *E. magna*, *E. media* and *E. irresidua* from rabbits and hares at Indian Veterinary Research Institute, Izatnagar, and U.P. But their
studies were based on the limited number of rabbits examined during post-mortem examination and hares hunted by the rural people of that area.

Martine and Yvone (1974) in their study observed two types of syndromes viz, deficiency of liver glycogen and Jaundice indicated by increased bilirubin. These were reported to be due to destruction of cells and obstruction of bile ducts with oocysts.

Renault et al. (1976) reported digestive disturbances associated with intestinal coccidiosis in 7 of the 13 breeding establishments in France.

Armoni (1978) showed that 48% of the rabbits which died on breeding farms of Pelotas in Brazil and that 64% of rabbits killed in slaughter houses were infected with *E. stiedai*.

Al-sadi et al. (1978) reported an outbreak of coccidiosis in a flock of rabbits in Mosul, Iraq. Congestion of viscera and the presence of small whitish spots in the liver and intestine were common findings.

Coudert et al. (1978) prepared assays of total protein, albumin and globulin of rabbit blood infected with *Eimeria intestinalis*. The principal changes observed at 10th day were total protein -20%, alpha-globulin +7%, beta-globulin +5.2%, gamma-globulin +3.6% and albumin -24% comparisons of control and infected rabbits suggested that electrophoresis can assist the diagnosis of coccidiosis of the rabbits.

Sugur (1978) reported the occurrence of *Eimeria* in rabbits caused by *E. stiedai, E. magna, E. media, E. irresidua* and *E. perforans*.

Catchpole and Norton (1979) recognised eight species of coccidia in 596 faecal samples from three commercial rabbitries in South east England. Mixed infection was common and 67 percent of the animals were found to be carrying 2 – 4 different species. *E. media, E. magna, E. perforans*
occurred most frequently where as *E. coecicola*, *E. irresidua*, *E. flavescens* were less common. *E. intestinalis* & *E. piriformis* were relatively rare.

Coccidiosis was reported in a rabbit farm in Moscow in association with the infection of *E. magna*, *E. stiedai*, *E. media*, *E. irresidua*, *E. piriformis*, *E. coecicola* and *E. intestinalis*. The protozoa were detected in the faeces of 18 day old young rabbits. It was observed that a combination of hepatic and intestinal coccidiosis was more common than either form occurring alone (Manzhos, 1979).

There was degeneration of all cytoplasmic structures in cells of the biliary epithelium of rabbits. The nuclei, which were sometimes multiple appeared like those of undifferentiated cells. In some rabbits with advanced hepatic lesions, oocysts and macrogametases were observed in the hepatic blood vessels and mesenteric lymph nodes (Rosmini and Simoni, 1979).

Zundel (1979) identified *E. intestinalis*, *E. irresidua*, *E. magna*, *E. media*, *E. neoleporis*, *E. perforans* and *E. piriformis* from the rabbits in France. Generally the rabbits were infected with two or three different species. It was further found that the poor hygienic conditions showed higher incidence of the infection.

Kastravets *et al.* (1980) reported coccidiosis in 27 farms in Moldavia. They also reported mass mortality of rabbits caused by 8 species of *Eimeria*.

Peeters & Halen (1980) in a study on coccidiosis in rabbits medicated them with 180 to 200 ppm coyden – 25 (metichlorpindol), 66 ppm cycostat (robenidine) and 82.5ppm whitsyn 10 (sulphaquinoxaline + pyrimethaimine 10:1) they observed that coyden 25 had effect on oocyst production and whitsyn 10 partially reduced oocyst excretion & clinical signs while cycostat markedly reduced both.
Barriga & Arnoni (1981) infected rabbits with sporulated oocysts of *Eimeria stiedai*. A phase of indirect damage to hepatocystes was identified during first 2 weeks. A stage of metabolic dysfunction began in the 3rd to 4th week and intensified during the next 3 weeks. Further, observations revealed that dysfunction of hepatocytes was characterized by hypoproteinaemia & hypoglycaemia with a period of immunodepression characterized by inability of host to inhibit oocyst production.


Jiang (1981) recorded a prevalence of 8.5% of coccidia in rabbits in Beijing, China. Seven species of coccidia identified included *Eimeria stiedai, E. exigua, E. media, E. perforans, E. magna, E. irresidua* and *E. piriformis*.

In commercial and domestic rabbitries in Belgium Peeters *et al.* (1981) reported nine *Eimeria* species in which *E. media, E. magna* and *E. perforans* were more common whereas *E. flavescens, E. intestinalis* and *E. stiedai* occurred more commonly in traditionally reared rabbits. *E. coecicola, E. irresidua* and *E. piriformis* were less common.

Peeters *et al.* (1981) in a study on coccidiosis observed enlargement of intestines and congestion with liquid to mucoid contents. In severe cases, the intestinal wall was corrugated and resembled the cerebral gyri.

Rakhimov *et al.* (1981) reported the presence of *Eimeria media, E. magna, E. stiedai, E. perforans* and *E. piriformis* in 500 rabbits in Uzbekistan, USSR.
Dash & Mahajan (1982) compared & treated 6 weeks old rabbits with furazolidone plus, nitrofural, Sulphaquinoxaline, amprolium or sulphadimidine. It was observed that amprolium & sulphadimidine gave the best results with respect to weight gain & wool yield.

In a survey of 14 rabbit farms, Igrasheva (1982) from Uzbekistan recorded the presence of *Eimeria media, E. magna, E. stiedai, E. perforans* and *E. piriformis*. In animals of 1.5 to 2 months age group 32.32% were infected while 22.2% adults were found infected with *E. perforans* and *E. media*.

Licois and Coudert (1982) reported detailed account of clinical coccidiosis in farmed rabbits in France and recorded nine species which included *Eimeria magna, E. irresidua, E. piriformis, E. intestinalis and E. flavescens*. They studied the chemoprophylaxis with various drugs on coccidiosis in rabbits & reported that robenidine was effective at 100 ppm against *E. intestinalis & E. flavescens* decoquinate (100ppm) & formosulphathiazole (750) against *E. Intestinalis* & Lerbek (clopidol & nequinate & pancoxin (amprolium + sulphamethoxazole + ethopabate) both at 200 ppm against *E. flavescens*.

In 1982, Meshkov carried out an extensive investigation on coccidial infection in rabbits of Burgos, region of Bulgaria on the basis of post mortem examination. A prevalence of 67.5% due to intestinal coccidiosis and 32.5% due to mixed (intestinal and hepatic) coccidiosis was reported.

Satyanarayana et al. (1982) reported an outbreak of coccidia in rabbits caused by both hepatic as well as intestinal species.

Coccidiosis was recorded in 954 out of 1069 (90%) rabbits in uzbekistan, USSR and caused high mortality (80%) in 20 - 60 day old rabbits Eimeria media, E. magna, E. stiedai, E. perforans and E. piriformis were identified (Sadykhova et al. 1982)

Gregory (1983) studied the intestinal histopathology after experimental infection of rabbits with Eimeria flavescens and E. irresidua. Features which distinguished E.flavescens from less pathogenic species included predilection for stem cells of crypts in the caecum and colon denudation of the affected mucosa and destruction of crypts.

In an experimental study coccidiosis with Eimeria stiedai in rabbits Joyner et al., (1983) evaluated the efficacy of sulphaqinoxaline (250 mg /kg of feed ), robenidine (66 mg /kg of feed ), Lerbek (comprising clopidol 200mg/kg & nequinate 16.7 mg/kg of feed) and found that only sulphaquinoxaline & lerbek were effective in terms of elimination of oocysts excretion, prevention of mortality & maintenance of growth rates.

From China, Lin et al. (1983) studied the prevalence in different regions during 1980 to 1982 and reported the presence of Eimeria stiedai, E. perforans, E. magna, E. media, E. exigua, E. irresidua, E. piriformis, E. coecicola, E. intestinalis, E. elongata and E. nagpurensis with infection rates of 67.4 % for E. perforans & E. magna 41.9% for E. media and 41.3% for E. stiedai.

Novinskaya et al. (1983) described coccidiosis in farm rabbits in the Saratov region, USSR. Eimeria perforans and E. irresidua were found to infect both young and adult rabbits, where as E. magna, E. intestinalis and
E. stiedai were recorded mostly in young ones and E. piriformis was mostly in adults. The highest intensity and prevalence was recorded in young rabbits. Seasonal observation of incidence has indicated that rabbits kept in untreated housing had the highest infection during summer and autumn period. They further reported that in the rabbits infected with experimental mixed coccidiosis total proteins, albumin, haemoglobin levels and erythrocyte numbers were reduced. While the leucocyte numbers and gamma-globulins increased.


In a survey during 1980 to 1982 in south Fujian, Hung et al. (1984) recorded the presence of Eimeria irresidua, E. flavescens, E. neoleporis, E. exigua, E. stiedai, E. piriformis, E. intestinalis, E. coecicola, E. perforans, E. magna and E. media with highest infection rates of 77.5 % for E. perforans.

Haupt and Hartung (1984) reported an incidence of 71.13% for intestinal coccidiosis in wild rabbits from leipzing area of German Democratic Republic during the period from 1976 to 1979.

An outbreak of coccidiosis caused by intestinal and hepatic species occurred during July and August (1984). The mortality recorded was 10 – 33% (Murty).

Murty and Rajkhowa (1984) studied the prevalence of Eimeria in rabbits of Mawali, India & reported 63 rabbits infected with E. irresidua, E. media and E. stiedai.
Peeters et al. (1984) studied the sequential pathology of small and large intestine and reported that the lesions were most pronounced in second half of small intestine followed by severe villous atrophy. 

Tassi and Puccini (1984), studied the effect of 125 ppm of sulphaquinoxaline. Rabbits were infected with 200,000 sporulated oocysts of E. media, E. perforans, E. irresidua, E. magna, E. piriformis and E. intestinalis. In this trial most of the rabbits died. A 2nd trail was performed in which rabbits were inoculated with 40,000 oocysts consisting of 60% of E. media, there were no mortalities, significant reduction in faecal counts, increase in body weight and feed conversion were better than in the untreated groups.


Brglez and Paradiznik (1985) reported 23 percent infection in rabbits from Slovenia (Yugoslavia). Eimeria media, E. piriformis, E. magna, E. irresidua, E. perforans and E. exigua accounted for mortalities upto 80%. 12.5% of rabbits showed infections in liver due to E. stiedai.

Fortineau and Stachurski (1985) reported nine species of Eimeria in a study from France. The species isolated were E. stiedai, E. intestinalis, E. flavescens, E. irresidua, E. magna, E. piriformis, E. media, E. perforans, and E. coecicola. The most pathogenic were E. intestinalis & E. flavescens which caused diarrhoea & deaths even at low parasitic burdens. E.
piriformis, E. magna & E. irresidua cause death only at high intensities of infection while E. media & E. perforans cause only transitory weight losses.

Pote (1985) conducted the study on incidence of intestinal coccidiosis in 15 rabbit farms in North West Arkansas and reported 60 – 100 percent Eimeria species infection in young rabbits than does or bucks.

Rai et al. (1985) reported an incidence of 4% coccidiosis in rabbits of Himachal Pradesh.

Gregory (1986) reported that a heavy infection of Eimeria flavescens led to failure of the crypts to maintain the integrity of the surface epithelium followed by widespread denudation of the caecal mucosa. The destruction of crypt cells appeared to be a crucial factor in the severity of lesions.

Gomez et al. (1986) infected three groups of rabbits with Eimeria stiedai in order to determine the total serum protein levels. It was recorded that total proteins and protein fractions in the infected rabbits increased to reach 10g/ 100ml compared to 6.5% 100ml in controls. Electrophoresis showed that the increase in total proteins were due to increase in alpha, beta 3-globulins, beta 2, beta30 and lambda – globulins.

Sanyal and Srivastava (1986) assessed the magnitude of sub-clinical coccidiosis in a rabbitry at central sheep and wool Research Institute, Avikanagar, Rajasthan and found that out of 92 faecal samples examined 48 (52.17%) were positive for the infection. They pointed out altogether eight species of Eimeria such as E.media, E. perforans, E. magna, E. irresidua, E. elongata, E. nagpurensis, E. piriformis and E. intestinalis. Further, they elucidated that 54.05 percent female and 48.93 percent male were acting as the reservoir of infection. Age wise prevalence revealed that 38.8, 100.0, 87.5 percent infection were detected in the age groups of adults, growers
and weaners, respectively. Breed wise prevalence was also reported as 84.0, 35.7, 69.2, 80.0 and 25.7 percent in New Zealand white, Soviet chinchilla, Grey giant, White giant and Angora, respectively.

Sherkov et al. (1986) reported occurrence of 6 species of coccidia in rabbits of Bulgaria which included *Eimeria magna*, *E. perforans*, *E. irresidua*, *E. media*, *E. intestinalis*, *E. piriformis*, *E. stiedae* and *E. exigua*.

Angora weaners were infected with 1, 00,000 of *Eimeria stiedae* and the lesions were mainly confined to the liver. The bile ducts were dilated. Changes were also observed in the lungs and intestine (Singh, 1986).

Ajayi et al. (1987) reported *E. magna* to be most predominant species causing coccidiosis in rabbits in Nigeria; other species observed included *E. media*, *E. perforans*, *E. irresidua* and *E. stiedai*.

Dousek et al. (1987) demonstrated coccidiosis in 1567 of 2700 dead rabbits examined between 1981 and 1985 with greater prevalence during the months of May, September and December.

Gomez et al. (1987) infected rabbits with $1 \times 10^4$ *Eimeria stiedai* oocysts and recorded marked difference in total serum globulins in the younger animals than controls.

Krishna and Vaid (1987) observed an outbreak of intestinal coccidiosis due to *E. perforans* in weaned angora rabbits from Palampur, H.P. The study revealed thickening, congestion with diffuse areas of haemorrhages in ileum and caecum along with the presence of thick and slimy material mixed with blood. Histopathological section of the intestine revealed characteristic lesions of intestinal coccidiosis along with presence of large number of macro and micro gametocytes and oocysts in epithelial cells of the mucosa.
Lineburg (1987) infected rabbits with sporulated oocysts of *Eimeria stiedai* and recorded small changes in haematological parameters, levels of total proteins and their fractions.

Coccidiosis was responsible for severe economic losses in commercial rabbit farms in Belgium, nine species of *Eimeria* were recorded with *E. magna*, *E. media* and *E. perforans* as the dominant species (Peeters *et al.* 1987).

Santos and Lima (1987) reported occurrence of *Eimeria perforans*, *E. magna*, *E. media*, *E. irresidua*, *E. stiedai* and *E. intestinalis* from four states of Brazil.

Zanger (1987) reported nine *Eimeria* species from the domestic rabbits in Germany. The frequency of occurrence was highest for *E. perforans* (92%) followed by *E. flavescens* (79%), *E. piriformis* (68.1%), *E. magna* (46.8%), *E. coecicola* (26.8%), *E. media* (21.2%), *E. stiedai* (11.2%), *E. irresidua* (10.3%) and *E. intestinalis* (10.2%).

While carrying out the prevalence of coccidial infection in domestic rabbits in Madhya Pradesh, Jain (1988) reported *E. media*, *E. perforans*, *E. piriformis*, *E. magna*, *E. exigua*, *E. irresidua*, *E. intestinalis* and unidentified *Eimeria* species causing clinical as well as sub clinical infections in the animals examined.

Lavicka and Zajicek (1988) examined livers of domestic diseased rabbits in Czech and reported hepatic coccidiosis with an incidence of 2.2%.

Meitei *et al.* (1988), examined 942 faecal samples of rabbits in Ranchi (Bihar) and reported an overall prevalence of 54.35%. The species identified were *E. magna*, *E. media*, *E. coecicola*, *E. irresidua*, *E. intestinalis*, *E. perforans* and *E. stiedai*. The seasonal prevalence was 66.35,
40.84, 55.45 in rainy, winter and summer seasons, respectively. Further, it was observed that there was a decrease in Haemoglobin and PCV values after rabbits were infected with mixed culture of intestinal species. The faecal oocyst count decreased with an increase in body weight gain in treated groups.

Peeters et al. (1988) in an observation from 61 commercial rabbitries of Belgium reported that the incidence of coccidial infection was markedly high and detected nine species of *Eimeria* which included *Eimeria magna*, *E. media*, *E. perforans*, *E. intestinalis*, *E. flavescens*, *E. piriformis*, *E. irresidua*, *E. coecicola* and *E. stiedai*.

Ponomarenko and Lapshin (1988) during their study in rabbits from Ukraine reported that the commonest *Eimeria* species were *E. magna*, *E. perforans*, *E. media* and *E. coecicola* whereas *E. intestinalis*, *E. irresidua*, *E. piriformis* and *E. stiedai* were less common. 68.2 % cases were due to intestinal coccidiosis, 13.6 % due to hepatic coccidiosis and both forms were prevalent in the remaining rabbits.

Sanyal & Srivastava (1988) reported that higher doses of *E. media* resulted in 25 to 50% mortality. Pathologically the intestines of dead animals showed elevated lesions in the middle half portion with congestion and destruction of villous epithelium.

Coudert (1989) reported that *Eimeria* are the only intestinal parasites which cause harm in rabbit farming.

Desplenter and Vanparijs (1989), recommended that diclazuril was quite useful for the treatment of both hepatic as well as for intestinal coccidiosis given orally at the dose rate of 1 ppm.
Mahmoud and Ibrahim (1989) reported 20% incidence of hepatic coccidiosis caused by *E. stiedai*. Unusual granulomas were observed during histopathological studies. These granulomata were large and involved a considerable area of the liver resulting in destruction and fibrosis of a large area of hepatic lobules.

Mundin and Barbon (1989) reported an overall prevalence of 33.5%, out of which 19.3% was found in young animals. A total of six species were recorded which included *Eimeria perforans*, *E. media*, *E. irresidua*, *E. magna*, *E. flavescens* and *E. coecicola*.

Efficacy of diclazuril was studied against robenidine resistant *Eimeria magna* in rabbits by Peeters and Geeroms (1989). Robenidine failed to reduce clinical signs, but oocyst output was reduced by 54%. Diclazuril on the other hand prevented the clinical manifestations of the parasite completely and reduced the total oocysts output by 99.9%.

Vanparijs *et al.* (1989) recommended the continuous medication of diclazuril @ 1ppm against intestinal coccidiosis in order to obtain 100% effectiveness.

Vitovec and Pakandl (1989) studied the pathogenicity of *Eimeria coecicola* in rabbits. The characteristic pathological changes included inflammatory infiltration and abundant pyogenic components in lamina propria, there was swelling and coalescence of upper parts of appendix where spaces were filled with stagnating inflammatory exudates. In addition endogenic stages of coccidia and desquamation of epithelia was observed. During 8 days post infection the epithelium became hyperplastic and proliferated into lamina propria. Necrosis of epithelium was also observed.

In a study on prophylactic effect of diclazuril @ 1 ppm, Vanparijs *et
al., 1989 observed that the drug was 100% effective in reducing oocyst output and faecal scores in rabbits infected with *E. perforans*, *E. magna* and *E. intestinalis*. Hepatic coccidiosis was prevented @ 0.5 and 1 ppm which resulted in reductions in oocyst counts and lesion scores with a normal liver weight and growth performance.

Zarzara *et al.* (1989) in their study from Romania reported an overall infection rate of 19.26% for intestinal coccidiosis and 0.09% for hepatic coccidiosis.

Balicka *et al.* (1990) during faecal sample and post mortem examination of rabbits in Poland revealed the presence of nine *Eimeria* species. The most prevalent species were *E. perforans*, *E. media*, *E. irresidua* and *E. magna*. The other species included *E. intestinalis*, *E. piriformis*, *E. flavescens*, *E. coecicola* and *E. stiedai*.

Chandra and Ghosh (1990) reported a prevalence of 53% of coccidial infection in rabbits aged between 1-2 months during June – December. The species recorded were *E. irresidua*, *E. perforans* and *E. media*.

Cheema *et al.* (1990) reported an out break of hepatic coccidiosis from an experimental rabbit colony maintained in Islamabad, Pakistan. Mostly young animals were severely affected. The bile ducts were dilated and an extensive proliferation of the biliary epithelium .Liver was enlarged and irregular whitish nodules were scattered on its surface.

Faecal samples of rabbits were examined in Malaysia from 1984 to 1989. The samples positive for *Eimeria* species were associated with *E. stiedai* (Lee *et al.* 1990).

Mundin and Barbon (1990) from Uberlandia city of Minas, Gerais recorded a prevalence of 75%. Species wise frequency recorded was
Eimeria magna (39%), E. media and E. irresidua (33%) each, E. coecicola (31.5%), E. perforans (27%), E. flavescens (6%) and an unidentified Eimeria species in 5%.

Okewole (1990) carried out faecal tests on 187 rabbits which revealed heavy coccidial infection with counts of 6000 to 600000 oocyst/g. faeces in 70% of the population examined.

Ong and Nazira (1990) reported occurrence of Eimeria stiedai in one month old rabbits. The symptoms included listlessness and slight distension of the abdomen.

Rabbits were experimentally infected with sporulated oocysts of Eimeria stiedai. Livers were heavier upto 10 times in infected animals. There was consistent bilirubinaemia and transient hypoproteinaemia and hypoglycaemia from 21 days after infection (Sanyal & Sharma, 1990).

Akram and Vassil (1991) reported a prevalence of 77.3% from domestic rabbits in Syria. A total of 10 Eimeria species were recorded which included Eimeria perforans (60%), E. coecicola (36%), E. magna (33.3%), E exigua (25.3%), E. irresidua (24%), E. matsubayashii and E. intestinalis (12%), E. piriformis (10.6%), E. media (6.6%) and E. stiedai (4%).

In a study on the comparative coccidiostatic efficacies of diclazuril, monensin and salinomycin against hepatic coccidiosis in rabbits, Jiang et al. (1991) suggested that diclazuril @ 0.5 to 2 ppm, monensin @ 40 ppm and salinomycin @ 50 ppm could control coccidiosis in rabbits.

Sanyal (1991) reported ten fold increase in weight of liver affected by Eimeria stiedai lesions in the form of yellowish white nodules scattered over the surface of liver. Microscopically, these lesions consisted of
proliferating biliary epithelia, developmental stages of coccidia with periportal fibrosis and degenerative changes of hepatocytes.

During a study on the incidence of hepatic coccidiosis in five breeds of rabbits from Taiwan, Wang and Tsai (1991) reported 95 to 100 percent prevalence in young rabbits. Adult female rabbits acted as carriers. They observed numerous scattered white nodules about 0.1 to 0.5 cm in diameter on the liver surface along with dark greenish mucoid exudate in intestinal lumen. Histopathologically lesions included hyperplasia of the bile duct epithelium with different developmental stages of coccidia within. Oocysts could also be seen in the lumen and granulomas were found to encircle the bile duct with infiltration of inflammatory cells.

Balasubramaniam et al. (1992) recorded the incidence of intestinal *Eimeria* in young chinchilla cross breed rabbits at a farm in Dharmapuri, Madras.

Jithendran (1992) reported 37.6% deaths of rabbits in and around Palampur, Himachal Pradesh. The species involved were *E. stiedai*, *E. magna*, *E. intestinalis*, *E. media*, *E. irresidua*, *E. piriformis*, *E. elongata*, *E. perforans* & *E. flavescens*.

Li et al. (1992) studied the pathological changes in hepatic coccidiosis of rabbits lesions were seen on the surface of the liver in the form of focal necrosis of hepatocytes. During the 1st two weeks of infection, the changes were characterized by degeneration of hepatocytes and infiltration of RBC's. Later on there was hyperplasia of fibrous tissue and bile duct epithelial cells. Fibrosis of infected liver was found to be the end result of chronic *Eimeria stiedai* infection in naturally infected rabbits.
Coccidiosis accounted for 37.5% of rabbit deaths over a 10 year period as reported by Placid et al. (1992). The various species included *E. magna*, *E. media*, *E. irresidua*, *E. elongata*, *E. nagpurensis*, *E. perforans*, *E. piriformis*, *E. coecicola*, *E. intestinalis* and *E. stiedai*.

Kintzel (1993) reported that diclazuril @ 1 ppm was more effective against coccidia than robenidine at 66 ppm.

Pillai and Subramanian (1993) reported an 89% of *Eimeria magna* in rabbits of kerala. The other species recorded were *E. perforans*, *E. media* and *E. intestinalis*.

Enteritis complex in domestic rabbits was studied in Canada. The species of *Eimeria* identified were *E. media*, *E. magna*, *E. stiedai*, *E. perforans* (Percy et al. 1993).

Kintzel (1993) reported that diclazuril @ 1 ppm was more effective against coccidia than robenidine at 66 ppm.

Polozowski (1993) investigated six rabbitries in Wroclaw district, average intensity of coccidia infection was 95%. Young rabbits up to three months of age were infected with five to nine species of *Eimeria*. The studies on the efficacy of various anti coccidial drugs on rabbits naturally infected with both hepatic as well as intestinal coccidia was investigated. Anticoccidials used included lasalocid (Avatec), maduramycin (cygro), robenidine (cycostat), salinomycin (Sacox), monensin (elancoban), clopidol + methyl benzoquate (Lerbek) and narasin (Monteban). The best results were obtained with salinomycin at the dosages of 35, 50, 25 ppm and maduramycin at 2 and 3 ppm.

Yin *et al.* (1993) studied the pathological changes of *Eimeria intestinalis* and reported that the villous were shortened and glandular
epithelial cells were enlarged. Many gland alveoli collapsed and lamina propria became homogenous.

In a survey of 20 rabbit rearing centres in 3 towns of Atlantic Department of Benin, 8 species of *Eimeria* were identified mostly in mixed infections of 5-7 species (Kpodekon *et al.* 1994).

During 1995, 28% of rabbits were infected with coccidiosis in a study by Al-Khafaji and Rhaymali from Mosul, Iraq. The species isolated included *Eimeria stiedai*, *E. perforans*, *E. media*, *E. intestinalis* and *E. irresidua*.

Jiunn and Cicero (1995) reported hypoglycaemia, hypoproteinaemia and hypoalbuminaemia when rabbits were infected with 50,000 sporulated oocysts of *Eimeria stiedai*.

Kintzel and Hasslinger (1995) evaluated the efficacy of robenidine and diclazuril against coccidiosis in rabbits @ 66 ppm and 1 ppm respectively and observed a marked fall in oocysts excretion with increase in weight gain. However, diclazuril was more effective in reducing the cases of catarrhal enteritis.

Tambur *et al.* (1995) recorded the incidence of various species of coccidia. *Eimeria perforans* accounted for 36 % where as other species like *E. flavescens* 24 %, *E. magna* 20%, *E. irresidua* 13 % and *E. stiedai* for 7 % of rabbits between January and May.

Jithendran and Bhat (1996) reported coccidiosis on the basis of examinations of faecal samples at 4 commercial angora rabbitries in the Kangra valley of Himachal Pradesh. *Eimeria magna, E. perforans* and *E. media* were the prominent species while *E. irresidua*, *E. stiedai* and *E. intestinalis* were less common. *E. piriformis* and *E. coecicola* were
relatively rare. The intensity of infection was higher in large private farms as compared to small govt. farms.

In another study, a prevalence of 57.3% was reported in four commercial angora rabbitries in the kangra valley of H.P. Mixed infections were common with 82% of the animals harboured more than two species (Jithendran and Bhat, 1996).

Junior et al. (1996) reported that Sulphaquinoxaline @ 500g/ton in feed was the most effective treatment to prevent hepatic lesions caused by *E. stiedai* in rabbits.

Rajkhowa (1996) recorded the prevalence of intestinal and hepatic coccidiosis from 1990 to 1993 in rabbits in Meghalaya. *E. irresidua, E. intestinalis* and *E. media* were recorded from the intestine whereas *E. stiedai* from liver. The prevalence ranged from 1.31 to 61.9%.


Sena and Suranarayana (1997) recorded decrease in haemoglobin content, packed cell volume and total erythrocyte count while increase in total leukocytes count were found in the affected animals. Decrease in total serum proteins and albumin levels were also recorded.

Rabbits were infected with 200,000 sporulated oocysts of *Eimeria media, E. neoleporis, E.magna* and *E. perforans*. Post mortem examination revealed catarrhal haemorrhagic enteritis. Grossly, the intestinal mucosa was reddish oedematous and covered with mucus. Histopathological examination revealed presence of developmental stages of coccidian in the
intestinal epithelium along the intestinal villi. Blood vessels were congested and erythrocytes were observed in discrete extra vasations. It was concluded that coccidiosis was the main cause of pathological changes and E. coli was a secondary infection, Tambur et al. (1997).

Biu and Nwosu (1998) recorded the prevalence of *Eimeria* species among domesticated rabbits in Maiduguri, Nigeria. The study was based on examination of faecal samples and bile duct contents from slaughtered rabbits and an overall prevalence of 31.90% was recorded with 9 species of *Eimeria* as *E. perforans* (28.4%), *E. media* (22.4%), *E. stiedai* (10.5%), *E. neoleporis* (10.5%), *E. intestinalis* (5.0%), *E. piriformis* (5.9%), *E. magna* (5.9%), *E. exigua* (4.5%) and *E. elongata* (5.9%).

Hobbs and Twigg (1998) reported that ten species of *Eimeria* were present in the rabbits of Australia with the incidence as *Eimeria exigua* 62.5%, *E. perforans* 84.2%, *E. intestinalis* 19.2%, *E. piriformis* 50.3 %, *E. media* 44.7%, *E. flavescens* 59.6%, *E. magna* 32.6%, *E. stiedai* 25.8%, *E. irresidua* 8.9% and *E. coecicola* 7.4%.

Jithendran et al. (1998) recorded a prevalence rate of 57.3% coccidiosis in rabbits of Kangra Valley, Himachal Pradesh. The overall mortality rate was found to be greater in weaners than in growers and adults. The intensity of infection by faecal oocyst counts was higher in big private farms than in small govt. farms.

Tambur et al. (1998) found significant decrease in total protein, albumin, urea and creatinine in rabbits infected with six species of intestinal coccidia.

Toula and Ramadan (1998) examined faecal samples of domestic rabbits from Jeddah, Saudi- Arabia and reported that 90% of the rabbits
were infected. Mixed infections of 2 or 3 species were more frequent. The species identified were *Eimeria perforans* (65%), *E. magna* (45%), *E. stiedai* (25%), *E. exigua* (20 %) and *E. piriformis* (10%).

Ajuwape *et al.* (1999) studied the histopathology of hepatic coccidiosis in rabbits and reported the liver was characterized by formation of irregular whitish nodules scattered on the surface extending into deeper parenchyma, characteristic histopathological changes in the liver with different developmental stages of *Eimeria stiedai* were also recorded. Liver showed periportal fibrosis with marked thickening of the bile ductules & infiltration of their walls by mononuclear cells mainly lymphocytes and plasma cells. The epithelia of the bile ducts were also hyperplasic.

Balikca (1999), in Poland reported 9 species of *Eimeria* in rabbits which included *E. magna, E. media, E. irresidua, E. coecicola, E. flavescens, E. piriformis, E. intestinalis, E. perforans* and *E. stiedai*.

Hobbs *et al.* (1999) estimated 8 species of *Eimeria* in 12 populations of wild rabbits in Australia.

Musongong and Fakae (1999), from eastern Nigeria reported a prevalence of 37.4% of *Eimeria stiedai* infection in rabbits. They further reported that the parasite was endemic to the region. Musongong & Fakae (1999), reported smears from liver nodules and bile sediments from infected livers showed oocysts of *E. stiedai*. The liver to body weight ratio, used as an index of gross pathology in infected rabbits, was significantly higher (p<0.05).

Al-Sadi and Al-Khafaji (2000) from Iraq observed 17% of rabbits were positive for coccidiosis. The infection was of hepatic type caused by
Eimeria stiedai, and intestinal type caused by E. magna, E. perforans, E. media, E. intestinalis and E. irresidua.

Gres et al. (2000) reported the intensity of Eimeria exigua in France and in a spontaneous study on occurrence of coccidiosis in rabbits, recorded that prevalence was highest in young than in adult rabbits.

Raida et al. (2001) in their study observed high incidence of disease in those breeding establishments where sanitation was poor. Histopathological findings in the liver consisted of extensive biliary hyperplasia with numerous intra lesional coccidia; bile ducts were markedly dilated and lined by hyperplastic columnar epithelial cells which were thrown into multiple papillary fronds. Numerous protozoal stages, including undifferentiated gamonts, microgametocytes, macrogametocytes and developing oocysts were within bile duct epithelial cells. Duct lumina were filled with numerous thin walled ovoid oocysts. The hyperplastic bile ducts were surrounded by large amounts of fibrous connective tissue with mild lymphohistiocytic inflammatory infiltrates. The small intestines were distended and filled with grey-green semi-solid ingesta.

Tambur et al. (2001) conducted study to determine the effect of intestinal coccidia infection in rabbit’s haematology. Two groups of rabbits were infected with $2 \times 10^5$ and $4 \times 10^5$ coccidia oocysts composed of 6 species. Following infection, haemoglobin concentration, RBC counts and haematocrit values decreased where as a rise was detected in white blood cell numbers.

Gres et al. (2002) reported a new species with a prevalence of 4 - 14% from wild rabbits in France. The prevalence was highest during winter and the species responsible was *Eimeria roobracki*.

In a survey of wild rabbit coccidiosis in France Gres et al. (2003) identified ten species of *Eimeria* viz *Eimeria perforans*, *E. flavascens*, *E. piriformis*, *E. exigua*, *E. media*, *E. magna*, *E. coecicola*, *E. stiedai*, *E. roobraucki* and *E. intestinalis*. It was further observed that in young kitten’s incidence was higher in spring and autumn than in summer.

Tambur and Kulisc (2004 a, b) reported a decrease in lymphocyte count where as the number of eosinophils remained unchanged. The number of neutrophils, basophils and monocytes was increased.

Pilar et al. (2005) reported a prevalence of 51% in rabbits from 1998 to 1999 in canary island.

Shameem & Devada (2005) recorded nine species of coccidia in rabbits of Thrissur, which included *E. magna*, *E. perforans*, *E. media*, *E. coecicola*, *E. flavescens* & *E. piriformis*. The percent prevalence recorded was 18.54 with high prevalence in 3 months old rabbits.

Darzi et al. (2006) reported hepatic coccidiosis in 56 rabbits belonging to different breeds during 2002 to 2005. Impression smears from liver nodules revealed presence of numerous developmental stages of *E. stiedai*. These were intermixed with sheats of hepatobiliary cells and inflammatory cells. The changes like biliary hyperplasia, cholangitis and vasuclar changes occurring in the liver were prominent.