CHAPTER - 2

REVIEW OF LITERATURE
2.1. Prevalence of Helminth Parasites

Castelino and Preston (1979) worked out the influence of breed and age on the prevalence of fascioliasis in sheep. Aged animals were found to be more susceptible to fascioliasis compared to young animals.

Dhar et al., (1988) made a longitudinal study on the prevalence of fascioliasis in Kashmir valley. On the basis of necropsy examination the prevalence of *Fasciola* spp. ranged from 0 to 100% in different areas of Kashmir valley and faecal examinations revealed 18.7% to 55.6% prevalence at Lolab in Kashmir valley.

Pandit et al., (1989) worked on epidemiology of Ovine fascioliasis in Jammu and Kashmir State. Both species of *Fasciola* viz., *Fasciola hepatica* and *Fasciola gigantica* were found in 30% and 70% of sheep examined respectively. The overall rate of infected sheep in epidemic areas (A), non epidemic areas (B), hilly and migratory areas (c) and autopsied animals (D) were 53.95, 43.46, 28.57 and 50.22 percent respectively. The study also revealed that the rate of infection due to *Fasciola* spp. started increasing from autumn reached to peak in winter and then declined in spring with lowest in summer seasons.

Sharma et al., (1989) conducted the study on the prevalence and laboratory transmission of fascioliasis in animals in Kashmir valley and found 51.3% of sheep and 14.8% of goats infected with *Fasciola* spp in Kashmir valley.

Choudhary et al., (1994) worked on the prevalence of fascioliasis in cattle at Savar, Dhaka Bangladesh and observed a significant effect of age on the prevalence of fluke infections. The prevalence of fascioliasis was more in aged animals compared to younger animals. No significant difference was
observed in the prevalence of the fluke infections between males and females.

Makhdoomi et al., (1995) worked on the incidence of different Ovine gastrointestinal parasites in Kashmir and reported 0.05% amphistomes, 1.38% *Fasciola* spp. 33.7% *Eimeria* spp. and 1.06% *Dicrocoelium dendriticum* in sheep in Kashmir valley.

Barger (1997) worked on the control of helminth parasites in sheep and suggested that co-grazing with resistant older stock may lead to decreased pasture contamination levels.

Arosemena et al., (1999) studied seasonal variation of gastrointestinal nematodes in sheep and goats from semi-arid area in Brazil and observed 95.9% prevalence in goats and 83.3% in sheep. They also observed varied seasonal dynamics of worm burden in sheep and goat.

Baker et al., (1999) studied the resistance to gastrointestinal nematode parasites in Red Massai, Dorper and Red Massai x Dorper ewes in the sub-humid tropics and observed increase in FEC in both breeds and their cross breeds, but more marked in the Dorper ewes.

Gargili et al., (1999) studied the prevalence of liver fluke infections in Trakya (Thrace), Turkey and observed 3.99% and 23.55% prevalence of *Fasciola hepatica* and *Dicrocoelium dendriticum* respectively.

Jarjees et al., (1999) conducted a study on prevalence of *Fasciola gigantica* in slaughtered water buffaloes at Mosul abattoir (Iraq) and observed 43.9% prevalence. Highest prevalence was observed in older animals than in younger animals.
Astiz et al., (2000) worked on the seasonal prevalence of lung worm infection of goats in Castilla-La Mancha and found 81% of lung worm infections. They also found zero percent prevalence of protostrongylids throughout the year.

Cavalcante et al., (2000) studied the prevalence of Paramphistomidae in goats from Sobral, Brazil and observed 6.38% of animals parasitized by adult Paramphistomidae. They also observed relatively high prevalence of parasites in Moxoto goats (53.49 %) compared with the non defined breed (17.44 %) and Anglo-Nubian goats (15.2 %) over a study period of eight years. Highest prevalence of Paramphistomes was recorded in two years of the study (30.23 %) and lowest in 7 years (2.33 %). Samples were identified as Cotylophoron travassosi, C. bareilliiensis and C. fullerborni.

Gastaldi et al., (2001) conducted a study to check the seasonal variation in egg counts of endoparasitic nematodes from sheep in Jabot cabal, Sao, Paulo state Brazil. They conducted the study in four categories (male and female yearling lamb, ewes and rams) and observed the average EPG values viz; 2271, 1928, 1424 and 1070 for female yearling lambs, male yearling lambs, rams and ewes, respectively.

Githigia et al., (2001) investigated the impact of gastrointestinal helminths on production in goats in Kenya observed normal PCV, live weight and decreased faecal egg counts in goats treated with albandazole. They concluded that the infection of gastrointestinal nematodes cause decrease in live weight and PCV.

Moriena et al., (2001) investigated the prevalence of Fasciola hepatica and other trematodes according to livers condemned in abattoirs in Corrientes (Argentina) and observed 2.83% prevalence of Fasciola hepatica infection.
Tamloorkar et al., (2002) worked on the incidence of fluke infections in ruminants of Marathwada region. Heavy infection was recorded during monsoon season. High prevalence was observed in indigenous breeds compared to cross breeds. Adult animals were found more infected compared to young animals. Higher fluke infections were recorded in males than females.

Par-Silva et al., (2003) worked on the prevalence of natural ovine fascioliasis by demonstrating the presence of serum circulating antigens and observed 59.5% prevalence. They concluded that the combination of ELISA and coprological sedimentation is extremely helpful for demonstrating current fascioliasis.

Khajuria and Kapoor (2003) conducted a study on the prevalence on helminth parasites in goats and sheep in Kathua of J & K on the basis of coprological examination. 78.92% faecal samples were found positive for parasitic infection. Mixed infection was found more (16.93%) in sheep compared to (8.15%) of goats.

Gorshi et al., (2004) intended to evaluate the prevalence of protozoan and endohelminth infections in goat and sheep flocks in Poland. The study was carried on 400 sheep and 180 goats. It was found that the prevalence of internal parasitic infection was higher in goats than in sheep. The most prevalent gastrointestinal nematode parasites were *Trichostrongylus* spp.

Moazeni and Nili (2004) examined intestines of 3165 slaughtered sheep in the Fars province of Iran for mixed tapeworm infection. 4.65% of animals were found to be infected with or more than one species including *Moniezia expansa, Moniezia benedeni, Thysanizia giardi, Avitellina centripunctata* and *Stilesia globipunctata*. Out of 148 infected sheep, 104 animals (70.3%) were infected with one species, 38 animals (25.7%) were
infected with two species and 5 animals (3.4%) were infected with three species of tapeworms. No animal was found to be infected with four species but one sheep (0.7%) was found to be infected with all five species of tape worms.

Pal and Subhasish Bandyopadhyay (2004) carried out a survey on the prevalence of gastrointestinal nematodes in 970 goats in 7 villages and some government farms of high hills of temperate and humid zones of Shim. Coprological examination revealed 77.13% of infection with gastrointestinal nematodes either as single or mixed infection with the mean number of eggs per gram of faeces (EPG) as 1166.7. The GIT nematodes isolated were *Haemonchus contortus* (70%), *Chabertia ovina, Bunostomum trigonocephlum* (51.66%), *Oesophagostomum columbianum* (43.01%), *Trichostonglus colubriformis* (28.33%), *Strongyloides papillous, Nematoderius spp.* (21.66%) and *Trichuris globulosa* (10%) and *Trichuris ovis* (6.66%) spp. Higher percentage of infection was observed in summer and autumn, as compared to winter and spring.

Pandit et al., (2004), surveyed gastrointestinal helminth parasites of cattle in Kashmir valley under two different management practices. A total of 741 and 1121 animals examined from organized and unorganized sector. 72.46% and 75.02% harboured parasitic infections respectively. The trematode parasites identified were *Fasciola gigantica, Dicrocelium dendriticum, Paramphistomum cervi, Gastrothylase crumenifer, Cotylophoron cotylophorum* and *Gigantocotyle explanatum*. Among the cestodes, *Moniezia expensa* and *M. benedeni* were most common. *Haemonchus, Ostertagia, Mecistocirrus, Nematodirus, Oesophagostomum, Bunostomum, Trichostrongylus, Trichuris and Strongyloides* were the nematodes identified.
Anwar-Maraq et al., (2005) conducted an abattoir survey of helminthetic liver and lung infections in local and imported sheep in Jordan. The study was conducted to compare the presence and infection rates of helminths of local and imported livers and lungs of 5596 sheep (443 local, 473 Romanian and 4680 Australian) slaughtered in Amman central abattoir. *Dictyocaulus filaria*, hydatid cyst, *Fasciola hepatica* and *Dicrocelium dendriticum* were recovered from the examined sheep with variable prevalence.

Cernaska et al., (2005) worked on the occurrence of sheep gastrointestinal parasites in the Slovak Republic. A total of 1519 sheep faecal samples were analyzed in order to determine the presence of parasite eggs. Strongyles eggs were identified in 1255 samples (82.6%), *Nematodirus* spp. in 148 samples (31.7%) *Strongyloides papillosus* in 431 samples (28.4%) *Moniezia* spp. In 291 samples (19.2%) and *Trichuris* spp. in 148 samples (9.7%). In 27 out of 37 examined sheep farms coprocultures were prepared and the third stage larvae were morphologically identified. *Ostertagia* spp. (100% of farms), *Tricostrongylus* spp. (92.6% of farms), *Chabertia* spp. (81.5% of farms) and *Oesophagostomum* spp. (48.1% farms), *Cooperia* spp. (37.0% of farms), *Nematodirus* spp. 22.2% of farms) and *Bunostomum* spp. (18.5% of farms).

Fernandes et al., (2005) conducted a study to evaluate quantitatively the in vivo infection levels of gastrointestinal helminth parasites of sheep using sugar and sodium chloride (NaCl) solution (with densities of 1225 and 1220, respectively) under the McMaster and modified centrifugal-flotation technique. 25 faecal samples of male and female sheep at different ages were examined McMaster's technique was found to be more reliable technique for quantitative estimation of worm burden.
Keyyu et al., (2005) conducted an epidemiological survey of *Fasciola gigantica* and amphistomes in cattle on traditional small scale dairy and large scale dairy farms in the southern highlands of Tanzania. Highest prevalence of fluke infection was observed in traditional system, moderate in the large scale dairy system and lowest in the small-scale dairy system in most parts of the year. Adults and yearlings had the highest prevalence of flukes in the management systems throughout the year.

Panayotova-pencheva (2005) conducted epidemiological studies on helminthiasis in goats and sheep caused by protostrongylidae in north eastern Bulgaria. Faecal samples of a mixed flock of sheep and goats belonging to private farm owners were collected on monthly basis between January 2004 and March 2005. Snails were also gathered around the pasture from 08:00-10.00h for identification. The infection intensity (IE) of protostrongylids in goats was 88.09%. The overall protostrongylid infection in sheep was 62.35% and the species observed were: *Muelleruis* spp. (50%), *Protostrongylus* spp (14.12%), *Neostrongylus* spp. (11.76%) and *Cystocaulus* spp. (11.28%). The IE of sheep was relatively constant during summer (66.7% to 77.8%) while monthly alterations were observed in the remaining months of the year. The average IE of sheep was high in February, April and December and constantly high during summer.

Phiri et al., (2005) evaluated the seasonal pattern of bovine fascioliasis in the Kafue and Zambesi catchment areas of Zambia. A total of 288 cattle were examined at the Turnpike slaughter slab for 1 year. Liver condemnation rates were relatively high at the beginning of both the cold dry season and rainy season (May/June and December respectively). High fluke abundances were observed in the post rainy-season (39.1% young and 42.1% adult) while the lowest rates were in the hot dry season (13.3% young and 14.3% adult). On coprological examination, the highest abundance was in the post rainy
season (45%) and the lowest in the cold dry season (24.9%) from November (end of dry season) to February/March.

Rauf et al., (2005) conducted a study on the prevalence of different species of tapeworm in sheep. The study was conducted in seven government and private farms in Pakistan from 2002 to 2003. A total of 1244 faecal samples were collected of which 803 samples were from government farm sheep belonging to different age groups (< 1 year, 1-2 years and > 2 year old). The overall prevalence of cestodes was 39.9%. The incidence of cestode infection was higher in private than government farms (31%). The species identified were *Moniezia expansa* (31.8%) and *Moniezia benedeni* (8%). High prevalence of cestode parasites was observed in autumn (39.5%) and summer (44%) than in winter and spring (21.1% and 33.3%) respectively.

Sanad and Al-Megrin (2005) conducted a study on the prevalence of fascioliasis among local and imported sheep in Saudi Arabia. Eight hundred and twelve local and imported sheep, slaughtered at the Riyadh abattoir, were subjected for parasitological and serological diagnosis of fascioliasis by detection of eggs in the stool and worms in liver, circulating anti-Fasciola antigens respectively. Detection of eggs revealed 13.5% infection rate compared with 21.9% by detection of worms. High infection rate was observed among imported sheep compared to local.

Troell et al., (2005) undertook a study to examine the ability of free living stages of *Haemonchus contortus* to over winter and cold stress. Eggs and larvae were monitored in climatic chambers at temperatures that fluctuated daily between -1°C and 15°C, or at constant temperatures of 5°C and 15°C. The development from egg to larvae was observed on temperatures over 5°C and long time survival was favoured at lower temperatures.
Umur and Yakari (2005) conducted an abattoir survey of gastrointestinal nematodes in sheep in the Burder region, Turkey. A total of 50 gastrointestinal tract were selected randomly from the local abattoirs between September 2000 and August 2001. 100% of infection was recorded during the course of study and twenty two nematode species were identified. The most frequently detected nematodes in the sheep were *Ostertagia circumcincta* (80%), *Trichuris skrjabini* (74%), *Trichuris ovis* (72%), *Marshallagia marshalli* (64%), *Nematodirus spathiger* (44%), *Trichostrongylus vitrinus* (42%) and *N. abnormalis* (40%)

Waruiru et al., (2005) intended to evaluate the prevalence of gastrointestinal parasites and liver fluke infections of small ruminants (sheep and goat). The effects of host species, season and age on the prevalence and intensity of helminth infection was determined. The faecal parasite egg and oocyst counts revealed that the overall prevalence was: *Strongyles* (51.6%), liver flukes (*Fasciola*) 31.5% and tapeworms of *Moniezia* spp. (2.5%). In both host species *Haemonchus contortus* (58.0%) was the most prevalent nematode followed by *Trichostrongylus* (29.0%) and *Oesophagostomum* (13%).

Kumar et al., (2006) undertook a study on the incidence of parasitism and disease in migratory Nellore sheep flocks. The incidence rate of amphistomiasis was significantly higher in migratory sheep flocks than in non-migratory flocks. *Moniezia infection was found in 8 and 11 samples examined from migratory and non-migratory flocks respectively. Fascioliasis, Strongyle infections and Babesiosis were high in migratory flocks compared to non-migratory flocks.

Pedreira et al., (2006) conducted a survey on the prevalence of gastrointestinal parasites of sheep in NW Spain. A coprological survey was
carried out from September 2001 to November 2002, and 1710 faecal samples were randomly collected from 49 sheep farms. Floatation technique was employed to determine the prevalence of gastrointestinal nematode parasites. 100% prevalence was observed and the genera identified were *Chabertia*, *Cooperia*, *Haemonchus*, *Nematodirus*, *Oesophagostomum*, *Teladorsagia*, *Trichostrongylus* and *Trichuris* species. A questionnaire was distributed to the farmers (at the same time of sampling) about parasite control practices during the year before.

Senlik *et al.* (2006) conducted a survey to determine the variation in the number of eggs excreted in the faeces at different hours of the day and the correlation between faecal egg counts and fluke burden in sheep naturally infected with *D. dendriticum*. Faecal samples were taken from 14 sheep at 1 h intervals from 07.00 to 19.00 h. Faecal samples were examined by the modified Benedek sedimentation method and mean egg counts per gram of faeces (EPG) for each hour (average of group) were calculated. In general, egg counts were found higher in faecal samples taken in the afternoon than those from morning. Although the highest EPG value was observed at 17.00 (61.3±16.9). The number of *D. dendriticum* recovered at necroscopy of each animal varied from 200 and 759. Positive correlation was observed between faecal egg count and total fluke count.
2.2. Histopathology and Haematobiochemistry

Hudson et al., (1962) worked on Isoenzymes of alkaline phosphatases and concluded that gastrointestinal diseases such as peptic ulcers and ulcerative colitis, to be responsible for release of enzymes from the affected mucosa.

Pradhan and Johnstone (1971) undertook the study on haematological response in sheep infected with helminth parasites and observed anaemia and general weakness in Haemonchus contortus infected lambs.

Allonby et al., (1975) worked on the epidemiology and pathogenicity of Haemonchus contortus in sheep and concluded that this abomasal nematode (Haemonchus contortus) is highly pathogenic gastrointestinal parasite, causes severe anaemia and death of animal in heavy infections.

Anosa, (1977) studied the haematological profile of a Nigerian Dwarf sheep infected with Haemonchus contortus and observed normocytic, normochromic anaemia characterized by low packed cell volume (PCV) and raised ESR.

Ackerman et al., (1981) conducted a detailed study on the filariasis and observed eosinophilia and elevated serum levels of eosinophil major basic protein and charcot - leyden crystal protein after treatment of patients.

Yakoob et al., (1983) studied the pathology of gastrointestinal Trichostrongyles in sheep and concluded that the consequences of parasitism are not limited to the local site of infection and the pathophysiological changes induced by the worms are the results of a cascade of processes based on multiple interrelations between the actions of the worms.
Al-Zubaidy et al., (1984) worked on pathology of abomasal nematode, *Ostertagia circumcincta*. The parasite was normally observed in deeper parts of infected gastric mucosa of abomasae.

Sing et al., (1984) studied histopathology of the duodenum and rumen of goats during the experimental infections with *Paramphistomum cervi*. Immature parasites were seen migrating to the muscularis layer, and the focal infiltration of macrophages and lymphocytes was observed in the lamina propria and in the intestinal tissue of Brunner’s gland. It was concluded that the immature forms of *Paramphistomum cervi* caused more severe damage in the duodenal tissue, whereas the adult form cause mild tissue damage in the rumen of the animals.

Al-Quaisy et al., (1986) studied the pathogenicity of haemonchosis in small ruminants in Iraq. Goats were found comparatively resistant to *Haemonchus contortus* than sheep as assessed by higher worm burden in sheep than goats.

Haroun et al., (1986) conducted a study on the natural resistance of sheep to *Fasciola hepatica*. Sheep were found more susceptible to *Fasciola hepatica* primary infection and were relatively less susceptible to reinfection.

Snider et al., (1988) conducted histopathological study on Type I, pre-Type II and Type II Ostertagiasis in cattle. Varied changes characterized by infiltration of eosinophils, glandular dilution and slight mucous cell hyperplasia with sub mucosal edema were observed in Type I Ostertagiasis. Glandular changes with prominent hyperplasia and marked lymphoid cell accumulation was observed in Type II Ostertagiasis. In the prolonged pre-Type II lymphoproliferation was observed.
Ahmed and Ansari (1989) worked out the effect of haemonchosis on the haematology and non specific phosphomonoesterase activities in sheep and goats and found that clinical signs like anemia, emaciation, decreased RBC count, Hb%, PCV and rise in serum ALP in sheep and goat haemonchosis in natural and experimental conditions.

McKeller et al., (1990) studied the pathological effects of abomasal nematodes and found histological alterations and high pH of stomach in *Haemonchus* or *Ostertagia* infected sheep and cattle.

Rehman and Collins (1990) studied changes in live weight gain, blood contents and faecal egg counts in goats experimentally infected with *Haemonchus contortus* and observed anaemia and fall in plasma protein levels.

Bhat and Sharma (1990) studied the changes in the haematological values in sheep experimentally infected with *Dictyocaulus filaria* (lung nematode) and correlated the alteration in various blood parameters with the status and the progress of the disease.

Kassi et al., (1990) undertook a study on the genetic resistance of Merino lambs to *Haemonchus contortus* infection and concluded that resistance of sheep to *Haemonchus contortus* is genetically determined.

McDougall et al., (1990) worked on haematological and biochemical reference values for grazing Saanen uninfected goats.

Abdel Ali (1992) conducted haematological studies on naturally infected sheep with strongyloid and reported normochromic anemia associated with eosinophilia in infected animals.
Gray et al., (1992) studied parasitological and immunological responses of Merino sheep on pastures contaminated with parasitic nematodes and concluded that resistance in sheep breeds to nematodes is genetically determined.

Motteleb et al., (1992) worked on effect of gastrointestinal nematodes on blood biochemical profile in small ruminants and concluded that nematodiasis is the main cause of weight loss, anaemia and diarrhoea. They also concluded that alteration is haematological profile is directly proportional to worm burden.

Chakerborty and Lodh (1994) studied the effect of Fasciola hepatica, Haemonchus contortus and Dictyocaulus filaria on blood biochemical profile and observed significant decrease in total serum proteins and serum albumin and marked increase in serum globulin levels in infected goats.

Marine (1996) observed high mortality from acute haemonchosis in two goat flocks in the province of Jhjuy (Argentina). 25% mortality was observed in female goats due to Haemonchus contortus infection. They also observed severe anaemia and gross pathological lesions at necropsy.

Misra et al., (1996) worked on haematological and histological alterations of immature paramphistomiasis in lambs and observed severe parasitism characterized by anemia and low packed cell volumes, decreased low red cell counts and haemoglobin concentrations.

Amarante et al., (1998) used nematode egg counts, packed cell volume and body weight as indicators to identify sheep resistance and susceptibility to gastrointestinal nematode infections. It was concluded that animals with high PCV value tend to be heavier and have low FEC.

Scott et al., (1998) conducted an experiment on Changes in the zymogenic cell populations of the abomasum of sheep infected with Haemonchus
contortus. At necropsy a variety of parameters including plasma pepsinogen concentrations, the wet weights of abomasal fundic mucosal pieces and the amounts of pepsinogen contained them, were assessed. Heavier fundic mucosa was observed in infected animals compared to uninfected control animals. Mucosal hyperplasia and decreased plasma pepsinogen concentrations were observed in *H. contortus* infected animals.

Anwar *et al.*, (1999) studied the pathological alterations in sheep liver naturally infected with *Echinococcus granulosus* and observed destroyed hepatic architecture with prominent changes near the cyst wall including increase in sinusoidal space and bile canaliculi.

Baker *et al.*, (1999) analyzed the genetic resistance in red Masai, Dorper and Red Masai x Dorper ewes in the sub-humid tropics. The Massai ewes were found to be resistant to gastrointestinal nematodes compared to Dorper ewes as lower faecal egg counts and higher PCV values were observed at most of the reproductive cycle. At most sampling times, the cross bred ewes were found to be more susceptible than the Dorper ewes in terms of both PCV and FEC.

Egbe-Nwiyi *et al.*, (1999) studied gastrointestinal parasitism and associated haematological changes in small ruminants in the semi-arid region of North Eastern Nigeria and observed anaemia with reductions in the packed cell volume, haemoglobin concentration and red blood cell counts in infected animals. They also observed eosinophilia with a reduction in the leucocyte and lymphocyte counts.

Paranagama (1999) evaluated serum pepsinogen concentration as a diagnostic aid in haemonchosis of goats and observed a positive correlation between serum pepsinogen concentration and *Haemonchus contortus* burden in abomasae.
Maiti (1999) worked on haematological and therapeutic studies in parasitic gastroenteritis in sheep and observed significantly decreased total erythrocyte counts, haemoglobin, lymphocyte counts, total proteins, and elevated eosinophil counts.

Rehman et al. (1999) studied some haematobiochemical changes in experimental bovine *Haemonchosis* and observed three fold increases in plasma pepsinogen and a four fold increase in blood gastrin.

Scherer et al., (1999) used puncture-biopsy technique for histopathological diagnosis in ovine fascioliasis and observed lesions in liver and destruction of liver cells.

Stear et al., (1999) studied the relationship between the number and size of nematodes in the abomasae and the concentration of pepsinogen in ovine plasma. They concluded that pepsinogen concentrations are strongly associated with variation in the number of trematodes present. They further concluded that variation in the pathogenic effects in lambs infected with *Ostertagia circumcincta* depends upon the mean size of the worms as well as the number of worms present.

Waweru et al., (1999) compared the serum biochemical changes in two breeds of sheep (Red Massai and Dorper) experimentally infected with *Fasciola gigantica* and observed decreased albumin levels in both breeds of infected animals without any significant difference. However, they observed elevated serum bilirubin and gammaglutamyl transferase in infected sheep with significantly more in the Dorper than Masai breed. On the basis of these findings they concluded that Dorper sheep are more susceptible to infection with *Fasciola gigantica* than red Masai sheep.
Diaz-Livera et al., (2000) studied the resistance of gastrointestinal parasites in Florida and Pelibuey sheep and their hybrids in the Mexican tropics. They observed altered values of haematological parameters in sheep naturally infected with nematode parasites.

Merkelbach (2000) studied the effect of *Haemonchus contortus* excretory-secretory products on abomasal acid secretion and observed decreased acid secretion by the abomasae infected with *Haemonchus contortus* parasite. They concluded that decreased acid secretion is due to accumulation of aminopyrine by gastric glands. They also concluded that a chemical factor, produced by stomach nematode *Haemonchus contortus* is involved in the reduction of acid secretion in the infected stomach.

Fuxiaoping et al., (2001) studied the dynamic changes of nitric oxide in serum of goats infected with *Fasciola hepatica* and found a positive correlation among nitric oxide, IgG and Eos, and concluded that these may influence disease resistance and prevention.

Iacob et al., (2001) investigated haematological profile of lambs experimentally infected with L3 larvae of normal gastrointestinal nematodes and refrigerated ones observed non-significant differences in red cell number but observed significant differences in haemoglobin concentration, haematocrit (%) and leucocyte counts.

Karira et al., (2001) investigated the role of parasitic diseases as a cause of mortality in small ruminants in a high potential farming area in central Kenya and observed 63% mortality in sheep due to parasitic disease (Helminthiasis). They also observed most of the helminthiasis cases were due to severity of haemonchosis.
Malan et al., (2001) conducted an experiment in South Africa to test the possibility of grading the colour of the ocular mucous membrane of sheep as an indication of the extent to which the animals are infected with *Haemonchus contortus* infection. They classified the observed colour shades into five categories, from red, through red pink, pink and pink-white to white according to the extent of anaemia.

Perez et al., (2001) worked on pathological and immunohistochemical study of the abomasae and abomasal lymphnodes in goats experimentally infected with *Haemonchus contortus* and observed marked hyperplasia, particularly of CD_{79} cells and IgG^{+} plasma cells in all infected goats. They concluded that these reactions may have been responsible for the reduction in the number of worms found in the abomasae between 3 and 7 week of infection.

Sharma et al. (2001) worked on the changes in the levels of serum enzymes and total proteins during experimental haemonchosis in Barbari goats and observed increased levels of ACP, ALP, SGPT and SGOT and significant decrease in TSP in infected animals compared to uninfected control.

Thamborg and Hauge (2001) observed osteopenia and reduced serum alkaline phosphatase activity in grazing lambs naturally infected with gastrointestinal nematodes.

Yacob et al., (2001) studied the mucosal inflammatory responses in sheep and suggested that the intensity of inflammation in the nasal mucosa is related to the intensity of infection with *Ostertagia ovis*.

Ardeleanu et al., (2002) studied the haematological and biochemical parameters of polyparasitic infections in sheep and concluded that nutritional
deficiency is caused by multiple infections. They also used severity of anaemia as a criterion for the implementation of treatment.

Baqui and Feroz (2002) studied haematological alterations in Ovine nematodiasis and observed marked decrease in Hb and PCV in infected animals corresponding to control.

Baruah *et al.*, (2002) conducted histopathological study in goats infected with Moneiziasis and observed shortening and flattening of villi characterized by infiltrating mononuclear cells with few plasma cells.

Bricarello *et al.*, (2002) studied the haematological, biochemical, clinical, and parasitological parameters in Corriedale and Crioula Lanada sheep after a single experimental infection of *Haemonchus contortus* and observed decreased value of total serum proteins, albumins, PCV and Hb in both the infected group of sheep.

Lawton *et al.*, (2002) investigated the effect of *Ostertagia circumcincta* excretory-secretory products on gastrin release in vitro. They tested excretory-secretory products of *Ostertagia circumcincta* on Ovine mucosal preparation which had been developed for a pharmacological study of gastrin secretion in the sheep. They concluded that hypergastrinaemia occurs due to *Ostertagia circumcincta* infection in sheep.

Pavlovic *et al.*, (2003) studied the effect of parasitic infections on sheep body weight and observed increase in body weight in dewormed animals.

Ziomko (2003) investigated the pathological and histochemical alterations in the small intestine of sheep experimentally infected with *Strongyloides papillosus* and observed necrosis of mucosa and destruction of
intestinal villi. They further observed the correlation between enzymatic activity and morphological picture of intestine.

Vanimisetti et al., (2004) studied the inheritance of faecal egg count and packed cell volume and their relationship with production traits in sheep infected with *Haemonchus contortus* and concluded that genetic merit for fertility and prolificacy were not related to parasite resistance. They also observed that lambs with higher genetic merit for body weight were more resistant to infection.

Simsek et al., (2004) undertook histopathological and morphological study to determine liver damage caused by *Dicrocoelium dendriticum* in severely infected sheep. Sclerotic liver and yellow-white coloured bile ducts were found on visceral and parietal surfaces. Thickened bile ducts and cholangiohepatitis were seen in the liver during the microscopic examination.

Huber et al., (2005) analyzed the effects of excretory-secretory products of *Haemonchus contortus* on cell vacuolation. Parietal cell vacuolation was observed in abomasal sections from parasitized sheep. Excretory-secretory products of adult and larval stages were collected. More extensive vacuolation was observed by adult worms than larval stage excretory-secretory products.

Liu et al., (2005) selected biochemical difference in Merino sheep as markers for resistance against gastrointestinal nematodes and also studied genetic and nutritional effects on faecal worm egg output. They observed reduced FEC in parasite resistant sheep.

Muresan et al., (2005) worked on haematological, biochemical and immunological parameters of experimental hydatidosis in lambs and observed
high leukocyte and eosinophil count in infected animals compared to control. They also observed decreased Hb % and erythrocyte counts.

Przemeck et al., (2005) evaluated the effects of excretory-secretory products of *Haemonchus contortus* and *Teladorsagia circumcincta* on physiology of abomasae. They observed inhibition of gastric acid secretion and vacuolation and the loss of parietal cells. Vacuolation of epithelial cells caused by the adult *O. circumcincta* or *L*3 of *O. circumcincta* or *Haemonchus contortus* ES products have been examined by differential interference contrast microscopy and by the neutral red uptake assay.

Shaikh et al., (2005) designed the study to elucidate histopathological alterations in liver of cow infected with *F. gigantica*. Infected livers were randomly collected from the abattoir of Hyderabad city, Pakistan. Tissue samples were fixed in 10% aqueous formalin and 6-8 micron sections were cut using standard histological procedures; grossly, the infected liver appeared swollen, with fibrotic bile ducts. Severe destruction of the liver architecture, with inflammation, atrophy, fibrosis and hyperplasia of the bile ducts was observed.

Sharma et al., (2005) studied haematological parameters of Barbari goats experimentally infected with *Haemonchus contortus*. Fluctuations in blood leukocyte counts was monitored in 12 male Barbari goats aged between 9-12 months orally infected with 5000 *Haemonchus contortus* larvae (*L*3). Significantly decreased number of neutrophils and lymphocytes was observed in *Haemonchus contortus* infected goats and eosinophil, basophil and monocyte number was in normal range.

Tsocheva-Gaytandzhieva, T. N. (2005) reviewed effect of fascioliasis on tumour growth and described that *Fasciola hepatica* could be a factor of potential neoplastic factor for humans and animals in natural conditions.
Wildblood et al., (2005) demonstrated experimentally that ruminant gastrointestinal trichostrongyles produce strong potent chemoattractant activity for ovine bone marrow derived eosinophils in vitro. The chemoattractant activity was observed in whole worm extracts of third and forth larval (L3 and L4) and adult stages of Teladorsagia circumcincta and Haemonchus contortus. Similar activity was detected in excretory/secretory (ES) material derived from live T. circumcincta L3 larvae.

Ahmad et al., (2006) studied the haematological and biochemical responses of Balami sheep to experimental Fasciola gigantica infection. The animals were treated against internal and external parasites and other infections prior to pre-conditioning. They were then allowed to acclimatize for four weeks during which baseline haematological and biochemical parameters were established. Decreased values of PCV, Hb and total protein were observed in infected sheep corresponding to controls.

Oruc and Uslu (2006) compared cytopathological and histopathological studies of sheep with suspected Coenurus cerebralis infection. Cerebrospinal fluid (CSF) smears were compared with brain imprints and histopathological sections of sheep with suspected Coenurus cerebralis infection. There was an increase in eosinophils, neutrophils, lymphocytes, phagocytic and epithelial cells in CSF smears. Purulent eosinophilic or necrotic granulomatous infection was observed in histopathological sections.

Padmaja et al. (2006) investigated haematological and blood biochemical profile of sheep with mixed endoparasitic infestation. Twenty sheep of various age groups, sex and breed were used for the experiment. Haematological and blood biochemical parameters were monitored on days 0, 15 and 30. A significant decline in total erythrocyte counts, hemoglobin, heamtocrit, serum total proteins, albumin and electrolytes with leucocytosis, neutrophilia and eosinophilia were recorded in the infected sheep.
Shirai et al., (2006) conducted anatomicopathological study of vascular and biliary systems using cast samples of *Fasciola*- infected bovine livers. The degree of pathological changes in the bile ducts caused by fascioliasis was classified into five levels. In the left lobe of liver, quadrate lobe, caudate process where atrophic fibrosis was noted, the bile duct became rod-shaped by losing branches and the samples resembled dead branches of liver. Portal branches were thinned or completely terminated with marked fibrosis. Distal portal branches in the right lobe, caudate lobe and papillary process showed hypertrophic proliferative changes.

Vaughan et al., (2006) investigated the effect of corticosteroid-induced immunosuppression on the plasma protein loss of lambs infected with gastrointestinal nematode. Reduced plasma albumin was observed in the lambs infected with *Teladorsagia colubriformis*. Loss of protein was observed in the alimentary canal in infected group.

Louie et al., (2007) worked on the effect of gastrointestinal nematode parasites on live body weight and concluded that parasite induces loss of appetite and reduction in the metabolic efficiency of the host which decreases nutrients available for maintenance and growth.

Phiri et al., (2007) investigated serum glucose and β-hydroxybutyrate levels in sheep with experimental *Fasciola hepatica* and *Fasciola gigantica* infection. Reduction in the serum glucose levels was observed in *Fasciola* infected sheep compared to uninfected control starting from 5 weeks post infection to the end of the experiment. Serum β-hydroxybutyrate levels were elevated in *Fasciola* infected animal compared to control. It was concluded that decrease in serum glucose and increase in serum β-hydroxybutyrate levels in infected sheep may help in understanding the interaction between fascioliasis and nutritional status of infected ruminants especially in young growing animals.
Raadsma et al., (2007) compared the immunological and plasma biochemical changes during early infection of *Fasciola hepatica* and *Fasciola gigantica*. At 6 weeks post infection, elevated levels of plasma GLDH were observed in the *F. gigantica* infected groups compared to the uninfected sheep whereas the *F. hepatica* challenged group had four folds higher levels of GLDH compared to the *F. gigantica* infected group. Elevated levels of GOT as an indicator of epithelial damage in the bile duct was only seen in the group challenged with *Fasciola hepatica* at 10 weeks post infection when it rose from below 100 IU/l to approximately 250 IU/l whereas no detectable increase in GGT was observed in any group challenged with *F. gigantica* infection. The white blood cell response to *F. hepatica* infection was biphasic with initial peak at 4 weeks post infection and a second peak at 9 weeks post infection. The biphasic response was also evident in the changes in the eosinophil counts and plasma hemoglobin levels.
2.3. Immunology

Archer, (1963) worked on the immune response of sheep and observed high eosinophil counts in parasitic infections and concluded that eosinophils are involved in immunologic reactions.

Kagan et al., (1974) conducted a study on epidemiology and diagnosis of helminth parasites and concluded that immunodiagnostic assays for helminth infections are hampered by lack of specificity due to cross-reactive antigens.

Farrel et al., (1981) undertook a study on the diagnosis of fascioliasis in calves using various crude *Fasciola hepatica* fluke extracts. The experimentally infected calves were found seropositive by ELISA after four weeks of infection.

Lightowlers et al., (1984) worked on serological diagnosis of *Echinococcus granulosus* infection in sheep using cyst fluid antigens processed by antibody affinity chromatography and concluded that only low levels of antibodies could be detected in naturally infected sheep.

Pfister et al., (1984) conducted an experiment on partial purification of somatic and excretory-secretory products of adult *Fasciola hepatica* and their application for the serodiagnosis of experimental and natural fascioliasis by ELISA. Six partially purified antigenic fractions from adult *Fasciola hepatica* (three from somatic tissues and three from excretory products) were used in micro-ELISA to monitor the serum antibody levels in rabbit experimentally infected with *Fasciola hepatica*. *Fasciola hepatica* excretory secretory antigens were detected between 12 and 19 days after infection while as crude somatic antigens were detected between 19-26 days of infection.
Santiago et al., (1986) worked on the identification of functional *Fasciola hepatica* antigens in experimental infections of rabbits. Studies were done by comparing the reactivity of serum from rabbits infected with a *Fasciola hepatica* crude tegument extract and *Fasciola hepatica* excretory-secretory antigens. A group of 7 polypeptides with molecular weights ranging between 23-28KDa were major antigens recognized in excretory-secretory products.

Parkhouse, *et al.*, (1987) studied the protective effect of nematode antigens and concluded that somatic antigens are poorly immunogenic compared to excretory secretory antigens.

Coles *et al.*, (1988) designed a comprehensive study on the cross reactivity of *Fasciola hepatica* and *Schistosoma mansoni* antigens. 27 KDa protease of *Fasciola hepatica* was found to show cross reactivity with *Schistosoma mansoni* antigens.

Lightowlers and Rickard (1988) reviewed the importance of excretory-secretory products and concluded that excretory-secretory products of *H. contortus* can elicit strong host antibody responses and may be used as potential sources of diagnostics.

Hillyer and Soler (1988) worked on the immunodiagnosis of fascioliasis and identified a 17-KDa *Fasciola hepatica* antigen by immunobloting and Enzyme-linked immunosorbent technique.

Hillyer and Solar *et al.*, (1991) worked on the feasibility of the FAST – ELISA for the immunodiagnosis of fascioliasis. Significant antibody levels were detected from second week of infection.

Jasmer and Mc Guire *et al.*, (1991) studied protective immunity of sheep against blood feeding parasite *Haemonchus contortus* and suggested
that parasite gut antigens can be used as best immunogens for vaccinating sheep against *Haemonchus contortus*.

Knox and Jones (1991) studied the parasitic enzymes for the diagnosis and control of ruminant nematodiasis and suggested that enzymes together with other E/S material secreted into the circulation of host could be become target of this system.

Fagbemi and Hillyer (1992) conducted a study on the purification of adult *Fasciola hepatica* antigens. 28 KDa protease antigen was purified and used for serodiagnosis of fascioliasis in cattle.

Hillyer, (1993) studied the antigencity of excretory-secretory antigens of *Fasciola hepatica* and concluded that excretory-secretory antigens are potent antigens which can be used for the serodiagnosis of fascioliasis.

Knox *et al.*, (1993) characterized proteases in crude homogenate of *Haemonchus contortus* and demonstrated inhibition of prominent 55KDa *Haemonchus contortus* proteases by sera of immune sheep.

Torgerson and Lloyd (1993) worked on the *Haemonchus contortus* soluble antigens that induce lymphocyte responses in naive lambs and immune sheep. Low molecular weight antigens of *H. contortus* were found to induce strong lymphocyte proliferative response in sheep.

Shaker *et al.*, (1994) purified and characterized the specific *Fasciola hepatica* antigen and observed seven immunodominant bands in the 12-54 KDa region of crude extract.

Schallig *et al.*, (1994) worked on the immune response of Texel sheep to excretory-secretory products of adult *Haemonchus contortus* and observed 15 polypeptides with the molecular weight ranging from 10 to 100 KDa. They
found 14 and 24 KDa proteins as potent antigens for the diagnosis of haemonchosis.

Febmi and Guobedia (1995) worked on immunodiagnosis of fascioliasis in ruminants using 28-KDa cystein protease of *Fasciola gigantica* adult worm as antigen in the falcon assay screening test enzyme-linked immunosorbant assay. 28 KDa cystein protease was found more specific and sensitive to primary sera of sheep infected with *Fasciola gigantica*.

Rodriguez-Perez and Hillyer (1995) detected excretory-secretory circulating antigens in sheep infected with *Fasciola hepatica* and *Schistosoma mansoni* by ELISA technique.

Winter *et al.* (1996) worked on the immune response of young lambs to a primary infection with *Nematodirus battus* and observed protective immune response mounted by naive young lambs to the primary infection of *Nematodirus battus*.

Schallig *et al.* (1997) partially purified low molecular antigens by gel filtration of whole worm homogenates or total adult excretory-secretory products. Purified fractions were tested in vaccination experiments to determine their ability to induce protective immunity against *H. Contortus*. 15 and 24 KDa antigens were found to induce strong protective immune response in sheep.

Maji *et al.* (1998) investigated electrophoretic pattern of *Paramphistomum* antigens and observed three common antigenic components in whole worm extract and detergent solubilized antigens and two in excretory-secretory antigen

Taha and Zaki (1998) studied clinicopathological and physiological changes in sheep infested with gastrointestinal nematode, *Strongyloides*
papillosus and concluded that *Strongyloides papillosus* infection in lambs may adversely affect their general health, but the use of Ivermectin can solve this problem.

Estuningsih *et al.*, (1999) characterized protein antigens from *Fasciola gigantica* using SDS-PAGE and immunoblotting techniques. Two antigenic proteins were found immunodominent in the whole worm homogenate of adult flukes.

Gracio *et al.*, (1999) conducted a study for rapid diagnosis of fascioliasis and monitoring the drug therapy using simple materials. They concluded that somatic crude extract of *Fasciola hepatica*, is useful for routine diagnosis. They also that circulating antigen of *Fasciola hepatica* should be used both for diagnosis and post-therapy monitoring.

Hansen *et al.*, (1999) studied the immune responses in Indonesian thin tailed and Merino sheep during a primary infection with *Fasciola gigantica* and observed biphasic IgE response in Merino and Indonesian sheep with the first response detected by day 14 and the 2"nd" response developed from 30 days post infection.

Joshi and Singh (1999) characterized two low molecular weight protective antigens of *Haemonchus contortus* by using affinity chromatography and SDS-PAGE techniques.

Losson *et al.*, (1999) investigated the serological and biochemical response of cattle naturally infected with *Fasciola hepatica* observed no correlation between body weight gains and other biological parameters. They concluded that herd diagnosis of fascioliasis might rely on the rise of specific antibody levels, possibly associated with increase in hepatic enzyme activities.
Molina et al., in (1999) worked on the cross reactive antigens of *Haemonchus contortus* and *Teladorsagia circumcincta* and observed the cross reactivity particularly in the molecular weight range 29-105 KDa. However, they observed that peptides with high (195, 152 and 119 KDa) or low (23 KDa) molecular weight were only faintly stained by heterologus sera.

Ines et al., (2000) vaccinated Manchego lambs against *Haemonchus contortus* with somatic fractions (p 26/23) of adult *Haemonchus contortus*. Lambs were immunized three times during the experiment. On day 43, lambs were challenged with 400 third stage larvae/kg live weight. 60% reduction in mean faecal egg counts and low packed cell volume values were observed in vaccinated animals. At necropsy, average burden in the vaccinated lambs was significantly lower to those found in unvaccinated challenged animals.

Bossaert et al., (2000) worked on cell-mediated immune response in calves to single-dose trickle and challenge infections with *Fasciola hepatica*. They employed peripheral blood mononuclear cell (PBMC) proliferation assay to study the cell-mediated immune response in eight Freisian calves experimentally infected with *Fasciola hepatica*. They also assessed hypersensitivity related to eosinophil and mast cell responses. They administered 500 metacercaria in a single infection dose and concluded that eosinophil response is not clearly correlated with the development of resistance to *Fasciola hepatica* in cattle.

Gonzalez-Lanza et al., (2000) used ELISA technique to study the kinetics of IgG antibody response to excretory-secretory and crude somatic antigens of *Dicrocoelium dendriticum* (trematoda) in experimentally infected sheep. They observed maximum antibody levels at 60th day post infection for both excretory- secretory and somatic antigens, although with slightly lower figures for later.
Gill et al., (2000) studied the production of cytokines by lymphoid cells, isolated from non-infected and *Haemonchus contortus* infected lambs. Particular attention was paid to difference in Th1 and Th2 type immune profiles between genetically resistant and random-breed animal groups.

Moskwa et al., (2000) studied the immune response against gastrointestinal nematodes in naturally infected Polish Wrzosowka sheep and observed a significant association between increased IgG responses and faecal egg counts. They concluded that the combination of antibody responses against different antigen preparations of *Haemonchus contortus* and faecal egg counts appear better for identifying resistant Polish Wrzosowka sheep than either method used in isolation.

Derbata et al., (2001) worked on the potency of three *Haemonchus contortus* antigens in the diagnosis of Ovine haemonchosis. 100 faecal specimens and corresponding blood samples were evaluated for *Haemonchus contortus* infection in sheep by ELISA utilizing somatic, circulating and coproantigens. Coproantigens were found more potent than the others in the diagnosis of sheep haemonchosis. SDS-PAGE analysis demonstrated three antigens are structurally similar.

Espino et al., (2001) conducted a study on isolation and immunological characterization of fatty acid binding protein isoforms from *Fasciola hepatica*. They used combination of molecular sieving chromatography and two step preparative isoelectric focussing for isolation of Fh12 protein, a fatty acid binding protein isolated from *Fasciola hepatica* adult worms. They observed it as a complex of 8 isoforms with identical molecular mass but different isoelectric points.

Fredes et al., (2001) purified two polypeptides of *Fasciola hepatica* (14 and 29 KDa) by electroelution and elevated their diagnostic value using
western blotting. They observed 95% and 97% sensitivity of the 14 and 29 KDa polypeptides respectively and specificity of 100% for both. They concluded that these antigens are useful for the diagnosis of the prepatent stage of *Fasciola hepatica* infection.

Hadighi *et al.* (2001) studied the application and evaluation of Dot-ELISA for diagnosis of experimental fascioliasis. They purified the *Fasciola gigantica* antigens for the evaluation of fascioliasis and concluded that Dot-ELISA is very sensitivity test for the serodiagnosis of fascioliasis.

Knox and Smith (2001) isolated gut antigens of GIT nematodes (contortin, H 11, H-gal, GP, GP1 and cystein proteinases) by chromatographic techniques and used them, in vaccination trials against gastrointestinal nematodes.

Leser (2001) conducted a study to examine the sensitivity of enzyme linked immunosorbant assay (ELISA) for detecting coproantigens of *Moniezia* in samples of sheep dung. They immunized rabbits and fowls with somatic antigens and then collected antibodies for ELISA test. They observed 80% sensitivity using coproantigens and concluded that this method can be an alternative to microscopic dung analysis with the advantage of having higher sensitivity.

Abshar *et al.* (2002) employed agar gel precipitation test for the diagnosis of fascioliasis. 110 sera samples from sheep experimentally infected with fascioliasis (*Fasciola gigantica*), hydatidosis, ornithobilharziosis and non-infected sheep. Out of 80 sera samples of sheep infected with fascioliasis (40 samples were taken 3 weeks after infection and 40 were taken 3 months after infection), 69 (80%) showed clear precipitation lines against *Fasciola gigantica* excretory-secretory antigens. 30 samples from other parasitic infections and 30 samples from non-infected sheep showed no precipitation
lines with this antigen. The sensitivity and specificity of this test was 86.3% and 100% respectively.

Balic et al., (2002) studied the mechanism of immunity to *Haemonchus contortus* infection in sheep and concluded that two different types of immune responses can be generated after challenge infection of immunized sheep. The first response occurs when tissue larvae are excluded from their tissue niche, it is associated with changes in globular leukocyte population but no mobilization of the local immune system. In contrast when challenge larvae reach their tissue niche, dramatic changes in the local immune system occurs, including infiltration of eosinophils.

Chiejina et al., (2002) studied acquired immunity in Nigerian West African dwarf goat to *Haemonchus contortus* infection. They used various parameters like faecal egg counts (FECs), circulating eosinophil response, packed cell volume and body weight as the indicators of infection. A strong correlation was observed between the worm burden and PCV.

Colditz et al., (2002) analyzed the use of lactin binding characteristics to identify gastrointestinal parasite eggs in faeces and concluded that the intensity of lectin staining varied with incubation time, incubation volume, concentration of lectin and concentration of eggs.

Kaur et al., (2002) worked on identification of immunodominant antigens of adult *Haemonchus contortus* using rabbit immune sera for western bolt analysis. They detected high antibody titer by dot ELISA against 91.2 KDa *Haemonchus contortus* antigen.

Merkelbach et al., (2002) investigated excretory-secretory antigens of *Haemonchus contortus* and concluded that abomasal parasites inhibit gastric acid secretion and reduce the number of acid secreting parietal cells either
through physical contact with gastric tissue, the release of inhibitory excretory-secretory products or by initiating the host inflammatory response.

Nishi et al., (2002) conducted an experiment to determine the serum antibody IgG dynamics in calves infected with *Haemonchus contortus*. They observed high level of protection, with a significant reduction in faecal egg counts.

Tliba et al., (2002) evaluated the hepatic NK cell response during the early phase of *Fasciola hepatica* infection in rats and concluded that NK cells could be another source for the early production of IFNY but provide no evidence that these cells are involved in early events associated with granuloma formation.

Valderrabano et al., (2002) conducted a study to examine the role of nutrition in the development of gastrointestinal (GI) parasitism, performance and pathophysiology of parasitism in female lambs. They observed that young female lambs fed on adequate levels of protein; an improvement in energy supply does not only improve carcase characteristics and enhanced the development of resistance to GIT nematode infection. They concluded that this might have decisive management implications for the control of parasitic infections in sustainable production system.

Vervelde et al., (2002) worked on the protection of sheep with recombinant excretory-secretory proteins of *Haemonchus contortus* and observed significantly decreased worm burden when lambs were vaccinated with recombinant 15 and 24 KDa antigenic proteins.

Dixit et al. (2003) attempted a study on the purification and characterization of 28 KDa cysteine proteinase for immunodiagnosis of tropical fascioliasis. Under non-reducing conditions of sodium dodecyl
sulphate-polyacrylamide gel electrophoresis (SDS-PAGE) the enzyme appeared as doublet (26-28KDa) and under reducing conditions only one band was observed (28 KDa). No cross reactivity was observed upto 8 weeks post infection (WPI) with weekly pooled sera of buffaloes and goats experimentally infected with *Paramphistomum epiclitum*.

- Dominguez-Torano *et al.*, (2003) studied the humoral and cellular response in lambs vaccinated against *Haemonchus contortus* with 26, 23 KDa molecular weight antigens and observed specific lymphoproliferative response and extensive reactivity of sera from p 26/23 vaccinated lambs.

Gupta *et al.*, (2003) purified the *Fasciola gigantica* antigens using affinity chromatography and SDS-PAGE techniques. They observed six antigenic proteins of 27.7 to 37.5 KDa molecular weights. They coated microtitration plate with the sample concentration of 15 μg/ml. detected antibodies in the sera (1: 2000 dilutions) of the infected animals as early as 2 weeks post infection (PI) and a peak absorbance value of 0.588 at 14 weeks PI. They concluded that 27.7 to 37.5 KDa antigens have promising diagnostic value.

Kwangsig *et al.*, (2003) worked on the diagnosis of fascioliasis in humans by using low molecular weight proteins of *Fasciola hepatica* and concluded that 8KDa protein of *Fasciola hepatica* is one of the diagnostic antigens in human fascioliasis.

Ruiz *et al.*, (2003) immunized goats with cysteine proteinases (P28, P34KDa) of adult fluke and detected antibodies as early as 2-3 weeks post infection against P28 which remained elevated through out the experiment. They observed delayed immune response against P34 (4-6 weeks post infection). They concluded that P28 cysteine proteinase may be reliable for immunodiagnosis of *Fasciola hepatica* infection in goats.
Sarkar et al., (2003) used DID and ELISA for the detection of anti-
Fasciola antibodies in buffalo sera and observed precipitation bands in DID
and considerable immunoreactivity in ELISA.

Ahmad et al., (2004) purified and characterized the Gigantocotyle
explanatum somatic antigens and found nine peaks. They tested antigencity of
each fraction by ELISA and concluded that low molecular weight antigens are
highly antigenic.

Bakker et al., (2004) vaccinated sheep with thiol-binding fractions
from excretory-secretory products and observed a positive correlation
between fecundity (number of eggs per female) and the cumulative EPG or
worm burden. Serum and mucus antibody levels of excretory-secretory
specific immunoglobulins increased after immunization and after challenge
for IgG, IgA and IgE.

Bishop et al., (2004) worked on the inheritance of host resistance to
gastrointestinal nematode parasite infections in commercial Texel lambs and
concluded that genetic resistance varies from individual to individual and
should be taken in consideration during the breeding program.

Bricarello et al., (2004) studied the correlation between worm burden
and immunological responses in Corriedale and Criola lanada sheep following
natural infection with Haemonchus contortus and observed decreased total
serum proteins (TSP) and (ALB) in both the breeds.

Cancela et al., (2004) used gel and ion exchange chromatography
technique for the purification, characterization and immunization of
paramyosin from adult stage of Fasciola hepatica. They first stated with the
crude extraction of paramyosin in high salt buffer followed by gel filtration
chromatography in two precipitation-solubilization cycles. In the second
experiment, ion exchange chromatography replaced the gel filtration step. In both the cases, the apparent molecular weight of dodecyl sulphate gel electrophoresis under reducing and non-reducing condition was 97 KDa and 200KDa respectively. The molecular weight was constant with the presence of a dimeric protein linked by disulphide bridges.

Endah et al., (2004) attempted to detect the coproantigens by sandwich ELISA in sheep experimentally infected with 300 metacercaria of Fasciola gigantica. The detection of coproantigens was found in four of the seven sheep within 5 weeks of infection and within 7 weeks of infection, coproantigens were detected in all experimental animals.

Ganga et al., (2004) studied the role of excretory-secretory metabolites of Fasciola gigantica in modulating the delayed type of hypersensitivity in the hosts (rats). They observed delayed-type of hypersensitivity by assessing alterations in footpad thickness. They further confirmed their findings by observing lower stimulation indices of peripheral blood mononuclear cell in rats sensitized with ESfGGA (Excretory-secretory Fasciola gigantica antigen) prior to the inoculation of SFgA (Somatic Fasciola gigantica antigens) than in non-sensitized rats receiving only SFgA.

Goneic et al., (2004) compared the crude and excretory-secretory antigens for the diagnosis of Fasciola hepatica in sheep by western blotting. Crude and excretory-secretory (ES) antigens of Fasciola hepatica were subjected to SDS-PAGE and western blotting analysis in order to identify protein bands that would enable the specific and sensitive immunodiagnosis of sheep. The specific protein bands of F. hepatica infection observed were 33, 39.5 and 42 KDa in excretory-secretory and 24, 33 and 66 KDa in crude antigen.
Harmsen et al., (2004) identified the novel *Fasciola hepatica* cathepsin L protease containing protective epitopes with the propeptide and observed significant reduction of fluke load after artificial infection.

Huntley et al., (2004) used a successful technique (developed in Scotland and Newzealand) to monitor ovine mucosal cell populations during the local immune responses in normal and pregnant sheep.

Johnson et al., (2004) employed coproantigen capture ELISA technique for the detection of *Teladorsagia (Ostertagia) circumcincta* in sheep and observed increased specificity and sensitivity when faeces were subjected to heat treatment. They also observed significant positive relationship with adult worm burdens.

Nayebzadeh et al., (2004) immunized Arabian sheep immunization with intestinal homogenate of *Haemonchus contortus* and investigated its effect on worm burden and EPG. They observed significantly decreased mean total number of worms in vaccinated lambs compared to that of control lambs.

Velusamy et al., (2004) detected circulating antibodies in cattle experimentally infected with *Fasciola gigantica* as early as 3 weeks post infection and observed peak of antibody titer by 10 weeks post infection.

Zhang et al., (2004) compared the humoral response of *Fasciola hepatica* and *Fasciola gigantica* in sheep and concluded that *Fasciola hepatica* infected sheep serum reacted only with the lower molecular weight antigens while *Fasciola gigantica* infected serum reacts with low as well as high molecular weight antigen.

Mattar et al., (2004) aimed to evaluate circulating anti-Fasciola IgA antibodies by ELISA technique, using two types of antigens surface
tegumental (ST) and excretory-secretory (ES) products. The study was carried out from October 2003 to March 2004 on 50 patients (19 males and 31 females) with fascioliasis (passing *Fasciola* eggs in stools). The circulating anti-fasciola IgA antibodies were detected with 98% and 94% of patients and the specificity of test was 93.4% and 89.7% using surface tegumental and excretory-secretory antigens respectively.

Aksoy *et al.*, (2005) worked on the diagnosis of *Fasciola hepatica* infection and suggested that stool examination and ELISA can be used for the initial diagnosis of fascioliasis. They further concluded that *Fasciola hepatica* infection comprises two stages hepatic and biliary, with different signs and symptoms.

Dasgupta *et al.*, (2005), characterized the *Fasciola gigantica* soluble somatic antigens. In an experiment *Fasciola gigantica* soluble antigens were isolated and purified by column chromatography (gel filtration chromatography). Two prominent peaks (GP₁ and GP₂) were obtained by ion exchange chromatography, these fractions were further resolved into P₁D₁, P₂D₂ and P₁D₃ and P₂D₁, P₂D₂ and P₂D₃ respectively.

Mageed (2005) undertook a study on the characterization of *Fasciola gigantica* partially purified worm antigens and their potency in the diagnosis of fascioliasis. Chromatographic analysis of *Fasciola gigantica* adult crude extract was undertaken using Sphadex G-200 and four fractions were isolated by this approach. The isolated fractions showed simple electrophoretic profile, as judged by SDS-PAGE, and compared with the complex profile of crude extract.

Moazeni *et al.*, (2005) analyzed the cross reactivity between excretory-secretory antigens of *Fasciola* species. Excretory-secretory and somatic antigens of *Fasciola hepatica* and *Fasciola gigantica* were prepared from
freshly collected flukes. Excretory-secretory antigens of both species showed strong positive reaction with antisera raised against excretory-secretory and somatic antigens of the parasite. In homologous combination of antigens and antisera, high absorbance values were observed in enzyme linked immunosorbent assay (ELISA) in comparison with heterologous combination. It was concluded that excretory-secretory and somatic antigens of *Fasciola* spp. have strong cross reaction with each other but the antigenic materials of excretory-secretory and somatic products of the parasite are not completely the same.

Revilla-Nuin *et al.*, (2005) focused their study on characterization and isolation of *Dicrocoelium dendriticum* antigens or their fractions that could be used for the immunological diagnosis of dicrocoeliasis. Somatic and excretory-secretory antigens were analyzed by SDS-PAGE and their specificity was evaluated by western blot with homologous and heterologous sera. The antigens were partially purified by chromatographic technique of gel-filtration (Sephacryl S-300) and ion exchange (DEAE-Sepharose). Western blot analysis using sera of ovine infected with *D. dendriticum* revealed eight main antigenic polypeptides ranging from 24 to 205 KDa for somatic antigens and seven for excretory-secretory antigens with apparent molecular mass in the range of 26-205 KDa.

Salimi *et al.*, (2005) developed ELISA technique for the detection of *Fasciola hepatica* antibody in serum of cattle. The assay was applied to sera from 258 naturally infected cattle, 256 non-infected cattle and six calves experimentally infected with *F. hepatica*. The diagnostic sensitivity and specificity of the ELISA test was 98% and 96% respectively. The results using sera from the experimentally infected calves showed that antibodies were first detected 2-4 weeks after infection.
Sithole et al., (2005) conducted a study on the excretory-secretory and crude somatic antigens of *Ostertagia ostertagia* of adult and larval stages. ELISA test was conducted using three *Ostertagia ostertagia* antigens, crude adult worm, larval stages excretory-secretory (ES) and adult ES. Results were expressed as optical density ratio (ODR) values. The results suggested that the antibody response (detectable by the ELISA) is mainly directed against ES antigens (especially L4) than crude adult worm antigen.

Yadav et al., (2005) investigated the importance of *Fasciola gigantica* cathepsin-L cysteine proteinase in the detection of early experimental fascioliasis in ruminants. Cathepsin-L proteinase was purified from *Fasciola gigantica* by two step alcoholic fractionation, followed by co-exchange chromatography. Purification strategy was evolved to eliminate other contaminating proteins. The purified cathepsin-L cysteine proteinase was assayed for detection of *Fasciola gigantica* experimental infection, as early as four weeks post infection by ELISA, Western blotting and Dipstick ELISA.

Yokananth et al., (2005) worked on the characterization of specific and cross reacting antigens of *Fasciola gigantica, G. explanatum, S. spindale* and hydatid cyst using western blotting technique. When probed with *Fasciola gigantica* infected cattle sera, the immunodominant 156KDa and 28KDa proteins of *Fasciola gigantica* were found common among the antigens prepared from hydrated cysts ingredients like germinal layer, fertile and sterile. While another protein of 34KDa was shared between *Fasciola gigantica* and antigen prepared from protoscolices. The immunoaffinity chromatography of *Fasciola gigantica* infected rabbit immunoglobins as legands isolated the immunodominant 34KDa and 28KDa proteins in dimmer form and the same were found immunodominant in *Fasciola gigantica*-cattle, *Fasciola gigantica*-buffalo and *Fasciola gigantica* sheep system.
Diaz et al. (2006) analyzed the IgG antibody response to *Calcocephorin daubnayi* (Digenea: Paramphistomidae) excretory-secretory antigen in naturally infected cattle from Lugo (Spain) by using ELISA procedure. They observed notable IgG response and concluded that IgG antibodies did not increase after challenge infection.

Phiri et al. (2006) studied serum antibody isotype responses of sheep and cattle experimentally vaccinated with excretory-secretory products of *Fasciola* spp. and concluded that there is strong IgG1 antibody response in early stages and strong IgG2, IgA response in later stages.

Simsek et al. (2006) evaluated the application of Western blotting and enzyme linked immunosorbent assay (ELISA) for the diagnosis of *Dicrocoelium dendriticum* in sheep using excretory-secretory (E/S) antigens. The E-S antigens were prepared from live adult *D. dendriticum*, which were obtained from slaughtered sheep at a local abattoir. In the SDS-PAGE analysis of *D. dendriticum* E-S antigen, 9 protein bands with molecular weights varying between 6 and 66 KDa with comassie staining and 14 bands between 6 and 205 KDa with silver staining were detected. The sensitivity and specificity of the ELISA test were 82.6% and 76.4% respectively.

Rathore et al. (2006) conducted an experiment on the identification of 66 KDa *Haemonchus contortus* excretory-secretory antigen that inhibits host monocytes. The protein was purified from adult worm extract and excretory-secretory products by an ion exchange and sepharose chromatography. The purified protein inhibited monocyte function in vitro as judged by decreased production of hydrogen peroxide and nitric oxide in the culture medium.

Sriveny et al. (2006) investigated the importance of cathepsin L cysteine proteinase from *Fasciola hepatica* in the diagnosis of bovine *Fasciola gigantica* infection. Five cross-breed bovine calves were
experimentally infected with 400 metacercaria/calf and evaluated for anti-
cathepsin L antibody response. *Fasciola gigantica* infection in these calves
could be detected 4 weeks post infection using an ELISA and Western
blotting with 100% sensitivity. The antigen was also used to detect *Fasciola
gigantica* field infection in cattle, by screening 256 sera samples of these
animals by ELISA, which demonstrated an overall infection rate of 26.95%.

Jasmer *et al.*, (2007) conducted a study to identify antigens from
*Haemonchus contortus* gut antigens that stimulate local CD4 T-lymphocyte
responses during the primary infection. Purified mucosal gut antigens of the
*Haemonchus contortus* were found to induce the abomasal lymph node CD4
and CD25 responses. An immunoaffinity purified fraction, enriched with *H.
contortus* apical intestinal membrane proteins was found to proliferate the
ALN lymphocytes.