2.1. Literature Review

Many scientists from all over the world paid their keen interest towards advancement of sheep farming and its management due to its high food and market value. Thus it is difficult to prepare a brief and comprehensive account of the topic with the huge monumental scientific tasks done so far throughout the world. However, attempts have been made to explore all the literature to focus on the progress of science regarding sheep farming and its disease management.

2.2. Gastro-intestinal parasitic infection and prevalence

Patnaik et al. (1973) reported the occurrence of *Oesophagostomum columbianum* in sheep throughout the year in Rajasthan.

Qadir (1974) in Bangladesh conducted a preliminary survey on the incidence of GI nematode infections of domestic ruminants and recorded two nematode species, *Trichuris ovis* (18.94%) and *Oesophagostomum* sp. (58%). Barus et al. (1976) in a study on the incidence of gastro-intestinal nematodes parasitizing domestic ruminants in Kabul, Afghanistan recorded *Trichostrongylus* sp., *Haemonchus contortus* and *Nematodirus* sp. Chellappa and Gopalakrishnan (1977) reported *O. columbianum* as the most prevalent species of gastro-intestinal nematode both in sheep and goats.

Ansari and Singh (1981) recorded the incidence (18.8%) of *G. pachyscelis* in sheep. The average worm burden recorded was 15.24% and the intensity of infection was minimum during the pre-monsoon, moderate during monsoon and maximum during the post-monsoon and winter, with the peak in the month of January. The other species recorded were: *B. trigonocephalum* (37.5%), *O. columbianum* (29.3%), *T. columbriformis* (36.6%), *H. Contortus* (33.2%) and *T. ovis* (40.4%).

Gray and Kennedy (1981) observed that sheep were infected mostly with *Nematodirus* spp., *Trichostrongylus* spp. and *H. contortus* at Flowers Gap Research Station, Broken Hill, New South Wales. Sood (1981) reported
that sheep and goats were commonly infected with gastro-intestinal nematodes, mostly *H. contortus* causing acute gastroenteritis in Punjab.

Dhar et al. (1982) studied the abomasum and intestinal tract of sixty two sheep of age group one to two years over a period of one year and observed various species of helminths like *Haemonchus contortus, Trichostrongylus axei, Bunostomum trigonocephalum, Chabertia ovina*. During the study of faecal sample examination of adult sheep aged two to four year comprising mostly pregnant and lactating ewes showed rise in *Strongyle* egg counts during the months of March and April. The egg count reached their peak during the month of September.

Cabaret (1983) reported that gastro-intestinal nematode infections in sheep comprised *Oesophagostomum venulosum* (42.9%), *Chabertia ovina* (27.6%) and *Trichuris* spp. (59%) in Morocco. The worm burdens were highest in winter season and early spring. Vercruysse (1983) reported that the prevalence and intensity of *H. contortus* and *O. columbianum* were higher during wet season and lower in dry season (May-June) in domestic sheep and goats of the Sahelian Zone of Senegal.

The mature and immature stages of paramphistomes had a definite seasonal pattern in sheep and goats, the mature stages being highly prevalent from May to September, whereas the immature stages were recorded from October to April with the peak prevalence during November to February (Gupta et al., 1985).

Ahmad and Ansari (1987) studied the prevalence of GI nematodes of sheep in Aligarh, Utter Pradesh, during January’ 1984 to December’ 1985 and observed *H. contortus* (70.2-75.5%), *O. columbianum* (67.5-72.4%), *B. trigonocephalum* (42.6-43.7%) and *T. ovis* (51.5-57.8%). The study also revealed that the prevalence of *H. contortus* was highest in June to November with the peak in the month of October (92%), while the peak prevalence of *B. trigonocephalum* was in March and April (50-54.8%).

Gupta et al. in 1987 studied the epidemiology of GI nematodes of sheep and goats in Haryana by means of faecal examination and GI tract
examination and reported that *Trichostrongylus* sp. and *H. contortus* were the predominant species throughout the year accounting for more than 80% of the total warm burden. Other species also recorded were *B. trigonocephalum, G. pachyscelis, Oesophagostomum* spp. and *T. ovis*.

Gastro-intestinal nematode infections were of common occurrence during monsoon and post monsoon season throughout India and their prevalence varied depending upon the prevailing environmental conditions of the place of study (Gupta et al., 1987 and 1988 and Swarnkar et al., 1996).

Islam in 1988 reported the prevalence (48.64%) of GI nematode parasites in sheep in Lusaka, Zambia and recorded *H. contortus* (21.12%), *O. columbianum* (18.56%), *T. ovis* (15.52%), *S. papillosus* (11.36%), *G. pachyscelis* (6.72%), *T. axei* (6.08%), *C. ovina* (3.68%), *O. circumcinata* (2.56%), *C. punctata* (0.48%) and *N. spathiger* (0.16%). In Gujrat, Momin and Avastthi (1988) studied the seasonal prevalence of *Oesophagostomum* spp. and *Trichuris* spp. in sheep and recorded that April and June were the most favourable months for development of *Oesophagostomum* spp. The intensity of *Trichuris* infection (EPG) was highest in the month of May and it gradually decreased to the lowest in the month of January showing a significant seasonal variation.

Sanyal (1989c) in a study on GI parasites in sheep and goat in Avikanagar (Rajasthan) during January to December (1984) reported that *Strongyle* egg count had an increasing trend from June onwards up to November in both the animal species. *H. contortus* was the most prevalent species in both animals, while *B. trigonocephalum, O. columbianum* and *C. ovina* were recorded rarely in sheep only.

Uriarte and Valderrabano (1989) carried out an epidemiological survey of parasitic gastroenteritis in sheep in north-east Spain and recorded that the most prevalent species were *Ostertagia* spp., *Nematodirus* spp., *Trichostrongylus* spp., *Haemonchus* spp. and *C. ovina* during May to June.
Ndao et al. in 1991 conducted an epidemiological survey on gastro-intestinal helminthiasis in fifty one sheep and fifty one goats on Senegal from October’ 1990 to September’ 1991. All the animals were infected with at least one helminth species. Three trematode parasites (*Fasciola gigantica, Schistosoma bovis, Amphistomum spp*.), two cestode parasites (*Moniezia expansa, Cysticercus tenuicollis*) and nine nematode parasites were identified. The most important parasite was *T. colubriformis* in goat while *H. contortus* in sheep. Chaudhri et al. (1992) recorded the occurrence of both acute and chronic infections of *F. gigantica* in sheep and goats in Haryana.

Fritsche et al. (1993) observed a very high prevalence (97%) of gastrointestinal parasitic infections in small ruminants in Gambia and the infections comprised sixteen helminth species, of which the nematodes in order of predominance were: *T. colubriformis* (96%), *O. columbianum* (82%), *H. contortus* (67%), *S. papillosus* (55%), *Cooperia spp.* (49%), and *Trichuris* spp. (12%). Tapeworm infections comprising *Moniezia benedeni, Avitellina centripunctata* and *Stilesia globulosa* were also prevalent (43%) and less frequently *Schistosoma bovis* and *Paramphistomum* spp. were also observed in sheep and goats. The worm burdens of *H. contortus, S. papillosus* and *O. columbianum* had a distinct peak in monsoon season (i.e. July to October), while *T. colubriformis* had the peak in the mid dry season. Hasslinger et al. (1993) examined important endoparasites in sheep and goats. They investigated seventy flocks of sheep coproscopically for the endoparasites and found many species of intestinal parasites in both sheep and goats.

In an abattoir study in Malaysia, Dorny et al. (1995) determined the prevalence and intensity of Trichostrongyle infection in sheep and goats and reported that *H. contortus, Trichostrongylus* spp. and *Oesophagostomum* spp. were the most prevalent and pathogenic species. They also observed that the intensity of infection was apparently not influenced by the small seasonal climatic variations.

El-Azazy (1995) in Soudi Arabia observed that 47.9% sheep and 43.8% goats harboured GI nematode infections comprising *H. contortus* and
M. marshalli as the most prevalent species. Over all worm counts and infection rates were lowest in winter season. Makhdoomi et al. (1995) reported Trichostrongylus spp. and Strongyloides spp. as the predominant nematode parasites in sheep. The prevalence of GI nematode infection had an increasing trend from March to May and again from June to November.

Swarnkar et al. (1996) observed the peak prevalence of GI nematodes in sheep during July to September, whereas the peak intensity (EPG) was in August and September. In this study they also recorded the prevalence of M. expansa. Thamsborg et al., (1996) in Denmark reported that the T. vitrinus, O. circumcinata and Nematodirus filicollis were the most prevalent GI nematodes in grazing sheep during the months from May to September.

Agyei (1997) in Ghana recorded the seasonal prevalence of Strongyle nematodes in sheep and reported Haemonchus sp., Oesophagostomum sp., Trichostrongylus sp. and Cooperia sp. as the prevalent nematode species. The prevalence of this gastro-intestinal nematodes was higher during the period of and soon after the rains and very low or nil in the absence of rainfall. Beriajaya and Copeman in 1997 studied the gastro-intestinal nematodosis in sheep and goat in west Java. Their study also revealed that the egg-counts were significantly lower during the late dry and early wet season due mainly to lower burden of Oesophagostomum sp.

Cheah and Rajamanickam (1997) in Malaysia reported the seasonal variation and prevalence of H. contortus and T. colubriformis in sheep. The monthly population of H. contortus fluctuated slightly except in the months of May and August but the number of T. colubriformis were comparatively higher in the months of October to December and again in March, but lower during April to June. Doligalaska et al. (1997) reported the prevalence and intensity of GI nematodes in Polish Wrzosowka sheep in Poland. The dominant species were H. contortus and T. circumcincta but Trichostrongylus spp., C. curticei, Nematodirus spp. and C. ovina were less prevalent in the host. The intensity of infection (i.e. EPG) was four times higher in spring in comparison to autumn. Sisodia et al. (1997) reported the incidence of
Eimeria ovinoidalis, E. crandalis, E. parva, E. intricate, E. ahsata and E. pallida in sheep of Western Rajasthan and they also correlated the epidemiological factors responsible for their occurrence and spread.

Jithendran (1998) in Himachal Pradesh reported that GI nematode infections comprising *H. contortus*, *Oesophagostomum spp.*, *Bunostomum spp.*, *Chabertia spp.*, *Strongyle spp.*, *Trichuris spp.* in migratory sheep and goats was highly prevalent (94%). The intensity of infection was higher during July to September. In a study on the epidemiology of GI nematode infections in Suffolk and Gulf Coast Native breed of sheep in United State of America. Miller et al. (1998) recorded that the prevalence and intensity was higher in spring in case of native ewes and lambs but lower in Suffolk ewes and lambs. The predominant GI nematodes found in Suffolk and native tracer lamb were *H. contortus* and *Trichostrongylus* spp. and a classic repeatable seasonal pattern of gastro-intestinal nematode infection occurred in both breeds of sheep.

Amarante et al. (1999) studied the prevalence and intensity of naturally occurring GI nematodes in Florida native, Rambouillet and crossbreed ewes and reported that faecal egg count was highest (EPG= one thousand) in Rambouillet ewes and similar in Florida native. The Prevalent species were *Haemonchus* spp. (64%) in Rambouillet sheep. Florida native and crossbreed ewes were resistant to GI nematode infections in comparison to other breeds. The peak mean EPG of Rambouillet ewes were in the months of May and July, while in Florida native and crossbreed ewes it was in the month of October.

Arosemena et al. (1999) reported that 95.9% of goats and 83.3% of sheep in the Inhamuns region of Ceara, Brazil, were infected with gastro-intestinal nematode parasites and the peak prevalence was at the beginning of the wet season (January, February and March). Rehbein et al. (1999) evaluate the accuracy of quantitative techniques for the enumeration of *Dicrocoelium* eggs in faecal samples; eggs were added to fluke free sheep faeces to achieve densities of twenty five, fifty, one hundred, two hundred,
four hundred or eight hundred eggs per gram. The faecal egg counts were
done by McMaster's method for flotation or by sedimentation techniques.

Jithendran et al. (2000) examined the prevalence of gastro-intestinal
parasites in sheep and goats of Himachal Pradesh, India and found the
prevalence in sheep and goats respectively as follows: *Fasciola* 9.6%, 8.8%;
*Amphistomes* 3.8%, 2.5%; *Dicrocoelium* 7.2%, 2.5%; *Schistosoma* 1.2%,
0.6%; *Moniezia* 2.7%, 1.3%; *Strongyles* 91.6%, 100%; *Strongyloides* 4.8%,
5.1%, *Dictyocaulus* 1.2%, 1.3% and *Trichuris* 14.3%, 1.3%.

Oncel (2000) conducted a study to determine the prevalence of GI
helminth infections in sheep. Helminth infections were detected in two
hundred eight (80%) out of two hundred sixty sheep during examination of
faecal samples. A total of twenty seven helminth species including two
trematodes, one cestode, two metacestodes, and twenty two nematodes were
found during the post mortem examination. The species detected during the
period included, *Dicrocoelium dendriticum* (26%), *P. cervi* (4%), *Echinococcus
granulosus*, metacestodes (30%), *M. expansa* (18%), *Cysticercus tenuicollis,
Taenia hydatigernaj* (2%), *O. circumcincta* (78%), *T. axei* (46%), *H. contortus* (3
8%), *T. vitrinus* (34%), *N. fihicollis* (32%), *C. ovina* (28%), *Cystocaulus
creatus* (28%), *T. ovis* (28%), *O. trifurcata* (20%) *T. globulosa* (8%).

Lindqvist et al. (2001) in their study on prevalence and intensity of
gastro-intestinal nematodes in sheep recorded *H. contortus, T. circumcincta,
T. axei, T. ovina, T. colubriformis* as the most prevalent species and observed
a progressively increasing rate of infection during summer season. In lambs
the prevalence and intensity were higher in autumn.

An epidemiological survey on gastro-intestinal nematode infection in
small ruminants in Central Kenya, Nginyi et al. (2001) recorded the seasonal
pattern with high level of infection occurring during two main seasons,
especially in March, April and October. *H. contortus* had higher prevalence
than *Trichostrongylus* sp. In this study the highest level of infection in tracer
lamb was in November, January, May and June. Vlassoff et al. (2001)
reported the epidemiology of GI nematode infection of sheep in New Zealand.
It was reported that development of free living parasites stages on pasture was highest in spring and autumn, whereas the lowest was in summer because of lack of moisture and was lowest during cold winter months.

Rehman and Ali (2001) assessed the month-wise prevalence of gastro-intestinal trematode, nematode and cestode in Damani sheep and goats in Pakistan. A total of ninety six positive gastro-intestinal tracts of sheep and goats (forty eight each) were examined. Trematode infection was 16.66% both in sheep and goats in the month of May, whereas in the month of June, July and August it increased to 25% in sheep. In goats a similar increase was recorded in June and July which dropped to 8.33% in August. Highest custodial infections in sheep and goats were recorded in the month of June (33.33%) and August (41.16%), respectively. The lowest nematode infections recorded in sheep in June (41.66%), which increased in July (50%), May (58.33%) and August (58.33%). The lowest records were observed in the month of June (41.66%), with an equal increase in May and August (i.e. 50%) in goats.

Colwell et al. (2002) reported prevalence and intensity of nematodes in slaughtered lambs from central Alberta. Two trichostrongyles, *T. ostertagi* and *N. helvetianus*, accounted for greater than 99% of nematodes recovered from gastro-intestinal tracts of forty seven lambs pastured in central Alberta during the summer season. Their prevalence and intensity increased from less than 10% and less than 50 worms or host, in late June, to greater than 80% and approximately one thousand worms or host by mid-July respectively.

Patra (2002) in West Bengal recorded 24.66% prevalence of *Fasciola* sp. infection based on abattoir studies in Garole sheep. Purohit (2002) in a study of paramphistomosis in Garole sheep in West Bengal, recorded 9.04% incidence of paramphistome infection comprising *Cotylophoron* sp. (60%), *Paramphistomum* sp. (48%), *Gastrothylax* sp. (32%) and *Fischoederius* sp. (24%). The highest incidence was recorded in the rainy season (11.65%).
Richter (2002) studied the gastro-intestinal tract of lambs for parasitic helminths. Eleven nematode species and one cestode species were recorded, which include *T. circumcincta, T. axei, C. ovina, O. venulosum, T. ovis* etc. and cestode *M. expansa*. Wanjala et al. in 2002 conducted a research on prevalence of parasitic infection in small ruminants in a post oral community in Narok district, Kenya and the investigation was done in one hundred fifty sheep and one hundred fifty goat during wet season (May to June) and dry season (August to September). The findings of the study showed that 52% of animals were infected. The most prevalent genera of GI helminthes identified were Strongyle group.

Woldemariam in 2002 reported *Haemonchus contortus* (91-100%) and *T. colubriformis* (90-100%), followed by *O. columbianum* (33-83%) and *T. ovis* (8-33%) in a study conducted on fifty lamb and fifty three kid during different seasons in mid-rift valley of Ethiopia.

Aydenizoz and Yildiz (2003) investigated the prevalence of Anoplocephalidae species in sheep and cattle. They examined small intestine of three thousand one hundred thirty three sheep and eight hundred seventy cattle. The infections were detected in 4.43% and 0.34 % sheep and cattle respectively. The species of anoplocephalidae recorded were *M. expansa, Avitellina centrzpunctata* and *Thysaniezia ovilla* in sheep and *M. benedini* and *M. expansa* in cattle. They observed that the rate of infection was highest in July (9.89%), lowest in September (1.32%) in sheep.

Uriarte et al. (2003) reported that GI nematodosis in sheep under an intensive grazing system was caused by the most prevalent species *O. circumcinata* followed by *H. contortus and T. colubriformis*. There was an increased egg output during January- May and after the end of June and July, which was the most important source of infection causing parasitism in permanent lambs. In the different agro-climatic zone of north-west India, Yadav et al. (2003) reported 77% prevalence of gastro-intestinal nematode infection in sheep. The infection comprising *Haemonchus* spp., *Oesophagostomum* spp., *Trichostrogylus* spp., *Bunostomum* spp. and
Trichuris spp. had the intensity in terms of EPG ranging from zero to twenty eight thousand.

Chaudhri (2004) reported that the major species of GI parasites infecting sheep and goats in India include the Paramphistomes (rumen fluke), liver fluke (F. gigantica and F. hepatica), blood flukes (Schistosoma spindale and S. indicum), GI nematodes (H. contortus, Trichostrongylus spp., Oesophagostomum spp., Strongyloides spp. and Trichuris spp.), tapeworm like Moniezia spp., Avitellina spp. and Thysaniezia spp.

Dhand et al. (2004) reported an outbreak of fascioliopsis in sheep and goat in Punjab. They reported that seventy goats and fifty sheep of different age groups were affected and these animals were suffering from high fever with diarrhoea. Among these animals forty sheep and five goats died before the investigation. Through post-mortem examination F. gigantica was recovered.

Hussain et al. (2004) studied the prevalence of cestode parasites and studied relative efficacy of five different anthelmintics used for control of cestodes in Rambouillet sheep. Out of total animals examined, 28% were found infected with cestodes. They found treatment efficacy of Albex, Systamex and Vety wormex as 100%. Manga-Gonzalez et al. (2004) opined hepatic marker enzymes, biochemical parameters and pathological effects in lambs experimentally infected with Dicrocoelium dendriticum.

A survey covering twelve states namely, Punjab, Haryana, Delhi, Rajasthan, Himachal Pradesh, Karnataka, Uttar Pradesh, Uttaranchal, Tamil Nadu, Andhra Pradesh and Kerala revealed 0.2 to 8.2% prevalence of Schistosoma spp. infection in sheep and 0.1 to 7.7% in goats. The infection comprised S. indicum only in Punjab, Haryana, Rajasthan and Himachal Pradesh, whereas, in Madhya Pradesh and other states it was S.spindale and S. indicum (NATP Report, 2004). Sheikh et al. (2004) examined ovine fasciolosis in Kashmir valley. They studied one thousand one hundred fifty faecal samples from endemic and non-endemic and hilly or migratory groups collected directly from the rectum. To compare the percent
prevalence, three hundred eighty nine livers of locally reared sheep were examined for the presence of flukes and they found both immature and mature flukes.

Nasreen et al. in 2005 reported that the GI nematode infection in sheep in Kashmir valley comprised of five types of nematodes namely, *Strongyle* (60.78%), *Trichostrongylus* sp. (35.56%), *Haemonchus* sp. (20.73%), *Nematodirus* sp. (3.66%) and *Marshallagia* sp. (1.37%). The overall prevalence was highest in summer season (67.14%) and lowest in winter season (44.31%). Singh et al. (2005c) in Ludhiana (Punjab) reported 78% prevalence of different helminthic infections in sheep. The GI helminths included *Strongyle, Trichuris, Strongyloides and Paramphistomum*, of which *Strongyle* infection was prevalent during and after rainy season. The prevalence of mixed helminthic infections was 11.52% of which the most common were *Strongyle* and *Moniezia* sp. Sreedevi et al. (2005) reported the occurrence of *Stilesia globipunctata* in sheep and attributed inappetance, rapid loss of weight, progressive dehydration and dark mucoid diarrhoea followed by death to this infection in Andhra Pradesh.

Craig et al. (2006) observed that large proportion of the feral sheep on Hirta died due to shortage of food. They observed that *Teladorsagia circumcincta* the predominant and most pathogenic nematode species in all age groups of Sqay sheep. It was shown that the burden of *Trichostrongylus* spp. decrease with the host age and *T. circumcincta* increase in burden over the first few age classes.

Mungube et al. in 2006 estimated the prevalence and economic losses caused by *F. hepatica* and *F. gigantica* in the ruminant production systems of Taveta division of Kenya. They also reported that liver condemnation rates differed significantly between bovines, caprines and ovines (p≤0.05) for *F. hepatica* (0.4%, 22% and 28%, respectively) and for *F. gigantica* (26%, 6.6% and 5.2%, respectively).

Saravanan et al. (2006) in Arunachal Pradesh reported 59.15% overall prevalence of GI parasitism in sheep and the parasites include trematode
(0%), cestode (11.27%), nematode (43.67%) and Eimeria sp. (31.00%). The nematodes included Strongyle (31.00%) and S. papillosus (28.87%) while Moniezia sp. was the only cestode recorded. The intensity of infection of nematode was very low i.e. EPG <50.

Yadav and Khajuria (2006) examined faecal samples (n= five hundred twenty) from sheep (n= two hundred forty five) and goats (n=275) from Jammu district which revealed a total of 83.07% gastro-intestinal parasitic infection. 83.24%, 80.00%, 84.72% and 80.55% infection was observed in sheep, lambs, goats and kids, respectively. Strongyles sp. (44.62%) were predominant followed by Amphistomes sp. (8.07%), Eimeria sp. (6.73%), Fasciola sp. (3.08%), Trichuris sp. (3.08%), Dicrocoelium sp. (1.92%), Strongyloides sp. (1.15%) and Moniezia sp. (0.96%). Mixed infection with one or more gastro-intestinal eggs or ova was also detected in 13.46% of animals. Throughout the year seasonal variation was recorded and was highest during rainy season (88.54%) followed by summer (83.15%) and winter (76.01%).

Skirnisson (2007) identified ten species of Eimeria in sheep of Iceland and the species were; Eimeria ovinoidalis predominated in all seasons with a relative abundance of 40.7%, followed by E. bakuensis (18.9%), E. weybriggensis (11.1%), E. granulosa (8.2%), E. parva (6.7%), E. ahsata (5.6%), E. faurei (4.2%), E. intricate (1.6%), E. pallida (1.6%) and E. crandallis (1.4%). All the ten species reported in central and western Europe, E. marsica, has also been identified in Iceland but in a different flock of sheep. Seasonal incidence differences were mainly observed for E. ovinoidalis, E. bakuensis, E. weybriggensis and E. granulosa. Spring and summer coccidiosis was rarely reported, probably due to the early releasing of ewes and their lambs to sparsely oocyst-contaminated grazing areas.

Al-shaibani et al. in 2008 collected herbage samples from selected sites from the Hyderabad district and analyzed for presence of parasitic larvae. Investigation revealed that the highest pasture larval counts were recorded in the month of August, which coinciding with summer rainy
season, whereas the lowest in the month of January, which coinciding with dry winter season. The infective larvae collected from pasture samples were *H. contortus*, *O. circumcincta*, *Trichostrongylus* spp., *S. papillosus*, *O. columbianum* and *C. ovina*. The infective larvae of *H. contortus* were the most prevalent and pathogenic.

Okaiyeto et al. (2008) examined the frequency and occurrence of single infection is 17.4%, double infections 39.5%, triple infections 37.9% and quadruple infections 5.8% among sheep. In this study most of the animals examined had low to moderate infection, suggesting that the infections were probably at sub-clinical level.

Tariq et al., (2008d) carried out the epidemiological studies of GI nematode parasites in sheep. The parasites recorded were in decreasing order of prevalence (%) in sheep were *H. contortus* (59.6); *O. circumcincta* (38.0); *B. trigonocephalum* (37.7); *C. ovina* (37.7); *Trichostrongylus* spp. (33.9); *N. spathiger* (29.4); *O. columbianum* (28.4); *T. ovis* (23.5) and *Marshallagia marshalli* (22.1). In the present study season, gender, age, and genotype were the factors that influenced the epidemiological prevalence of GI nematode in sheep. The maximum nematode infection was recorded in summer season and lowest in winter (P=0.0005).

Biu et al. in 2009 conducted a faecal survey of ova or oocysts of gastro-intestinal parasites of ruminants on the University of Maiduguri Research Farm using saturated sodium chloride floatation and formol ether sedimentation techniques. The prevalence rate of 47.0%, 54.0% and 58.0% was obtained for cattle, sheep and goats respectively (p>0.05). The younger ruminants were more infected (cattle: 50.0%; sheep: 54.7%; and goats: 58.1%) in comparison to the older ruminants (cattle: 44.0%, sheep: 52.8% and goats: 57.9%) (p>0.05). Female ruminants were also more infected (cattle: 52.0%; sheep: 60.4%, and goats: 62.7%) in comparison to the males (cattle: 52.0%; sheep: 46.8% and goats: 51.2%) (p>0.05).

Chandrawathani et al. (2009) reported the occurrence of GI helminth and protozoan infections on small ruminants from eight farms in Kinta and
Perak Tengah district, Perak. The results of this investigation indicate that helminthiasis and coccidiosis is rampant in sheep and goat farms. Several anthelmintics have been used to control the GI helminth parasitess.

Based on faecal examination Dubinsky et al. (2010) revealed 54.5% of specimens being infected with one or more helminth species and a high prevalence of eimerid coccidia (91.89%). *Trichuris leporis* (55.41%) was the most prevalent helminth species. Lower prevalence was observed for *Passalurus ambiguous* (12.16%) and *Trichostrongylus retortaeformis* (6.76%). The intensity of infection rate was low for all parasite species. As for coccidia, *Eimeria semisulcata* (74.35%) and *E. leporis* (61.54%) were observed in all districts. Other coccidia showed lower prevalence rates: *E. robertsoni* (15.38%), *E. europaea* (12.82%), *E. babatica* (12.82%), *E. hungarica* (5.13%) and *E. towsendi* (2.56%), occurring only in some districts. The highest infection rate was observed in *E. semisulcata*, 7657.8 oocysts per gram (OPG) of faeces.

Sultan et al. in 2010 carried out a study on one hundred eighty nine slaughtered sheep of local breeds and observed ninety eight (51.9%) had helminths infection, the recovered species were identified as *Fasciola* spp., *P. cervi*, *M. expensa*, *A. centripunctata*, *Cysticercus tenuicollis*, *H. contortus*, *Parabonema skrjabini* and *Graphidiops* spp. Tavassoli and Khoshvaghti (2010) in Iran studied on forty one wild sheep (*Ovis ammon orientalis*) from Kabodan Island of National Park of Urmia Lake. The intensity of infection for Strongylid form, *Marshalagia*, *Trichuris* eggs, and lung worm larvae were eight (19.5%), twelve (29.5%), seventeen (41.5%) and fourteen (34.1%), respectively. Thirty three (80.48%) out of forty one wild animals were infected to one or more *Eimeria* species including *E. parva*, *E. ahsata*, *E. ovinoidalis* and *E. faurei*.

Nabavi et al. (2011) reported that the overall percentage of infection was 30.98% and *H. contortus*, *T. circumcincta*, *M. marshalli*, *O. occidentalis*, *O. trifurcata* and *Parabronema skrjabini* were six species identified in all three studied areas. The overall prevalence and intensity of worm burden as
representative of Iran, as well as in each of three different climatic zones were low, although *Teladorsagia circumcincta* was the most prevalent and frequent worm species found.

Based on faecal and post-mortem examination Mohamed (2012) observed in lung worm infection and assumed with regard to age, generally, highest prevalence (28%) was observed in small ruminants of six to twenty four month age groups while the lowest prevalence (24.5%) was observed in animals of age groups greater than twenty four months. Possible reason for the present finding could be due to the fact that, animals in semi intensive management system were grazed in the same pasture with extensively grazing animals; feeding moist pastures in the field until environment temperature rises like those of extensively managed small ruminants in the area.

Molla and Bandyopadhyay (2013a) conducted a study on Bonpala sheep in ‘Teesta river’ valley, West Bengal to investigate the prevalence of gastro-intestinal parasites (GI). The overall prevalence rate was very high (72.22%). The prevalence of *Haemonchus* sp., *Oesophagostomum* sp., *Trichuris* sp., *Trichostrongylus* sp. was 61.11%, 45.56%, 30.00% and 11.11% respectively and the mixed infection (57.78%) was also observed. Maximum infection was observed in young age group (80.00%) in comparison to older age group (62.50%). Sex wise prevalence of gastro-intestinal nematode parasites was higher in female (76.67%) in comparison to male hosts (63,33%). There was a significant seasonal variation in prevalence of gastro-intestinal nematode infections in Bonpala sheep. Season wise, the prevalence of GI parasitic infections was significantly lower in summer (56.00%) in comparison to monsoon (82.86%) and winter (73.33%). Although monsoon recorded the highest prevalence.

2.3. Haemato-biochemical impact of gastro-intestinal parasites including haemonchosis

Kuttler and Marble in 1966 observed significant reduction in total serum protein (TSP) and serum albumin (SA) and increased serum globulin
(SG) in sheep infected with *H. contortus*. Protein excretion into the intestine causes a decrease of blood total protein concentration, particularly albumin, which has an impacting effect on protein metabolism in livestock (Nelsen and Anderson, 1967).

*Haemonchus contortus* live in the abomasum and cause to proliferation of epithelial cells. Then, the blood proteins especially albumin leakage into the abomasum and macromolecules such as proteins couldn’t absorb (Murray et al., 1970). Experimental haemonchosis in lambs results in decreased haemoglobin (Hb), packed cell volume (PCV) and causes leucopenia (Sahai, 1971).

Experimentally induced severe haemonchosis in sheep resulted in decreased level of serum iron and serum albumin after ten days of infection and the infected sheep developed bottle jaws due to hypoproteinemia (Altaif and Dargie, 1978). Ogunsusi in 1978 observed that gastro-intestinal nematodosis due to *Haemonchus* sp. and *Trichostrongylus* sp. caused rapid decline in total erythrocyte count (TEC), packed cell volume (PCV) and haemoglobin (Hb) level in sheep. Kessler et al. (1981) reported that small ruminants infected with gastro-intestinal strongylidae had distinct anaemia.

Hunter and Meckenzie (1982) reported a decline in Hb and PCV value till thirty five days of infection with *H. contortus* in sheep. Thereafter, these values had a rising trend indicating the activation of the host's erythropoietic system and compensatory response to the infection. Amongst gastro-intestinal helminths of sheep *H. contortus* is the predominant and pathogenic species. The main pathological lesion caused by *H. contortus* infection is anaemia. Both fourth stage larvae and adult suck blood and in addition, migration of adult and larvae cause haemorrhages into the abomasum (Soulsby, 1982).

Infection with *H. contortus* and loss of blood into the abomasum does not necessarily impair the metabolic protein supply, because the post abomasal processes compensate its complications (Abbott et al., 1984). The high performance is recorded in all the animals when they are able to
absorb maximum amount of the diet protein, which lead to increase in the flux of essential amino acids to small intestine and followed by increasing the absorption of these components to blood circulation. Costa et al. (1986) reported that lamb infected with Haemonchus sp. had reduced total erythrocyte count (TEC) and eosinophilia. Ahmad and Ansari (1989) reported a significant increase in serum alkaline phosphatase activity in sheep either naturally or experimentally infected with H. contortus.

Gastro-intestinal helminth infection in sheep was incriminated as the cause of declined level of total erythrocyte count (TEC), packed cell volume (PCV), haemoglobin (Hb) and lymphocyte count (Mottelib et al., 1993). Gastro-intestinal parasites cause development of immature cells which lead to formation of weak cell junctions in the host body. Therefore, macromolecules such as proteins enter the abomasums and intestine through mucosa (Murray, 1970 and Holmes, 1993). Yadav et al. (1993) observed that haemoglobin (Hb) and PCV level was significantly lower in relation to higher faecal egg count and worm burden of H. contortus in sheep. They also reported that damage of GI mucosa caused by GI nematodes resulted in leakage of plasma protein causing hypoproteinemia and loss of body weight.

A significant decline in Hb, TEC, PCV and a significant increase in erythrocyte sedimentation rate (ESR), total neutrophil and eosinophil count was observed in sheep experimentally infected with H. contortus (Ghulam et al., 1995). Stear in 1995 reported an inverse relationship of the faecal egg count of H. contortus and total erythrocyte count (TEC) in Scottish Black Face Lamb.

Hayat et al. (1996) reported that values of erythrocyte count, haemoglobin and PCV were significantly declined in lambs experimentally infected with H. contortus and T. colubriformis. Infection with gastro-intestinal nematode parasites, T. colubriformis and H. contortus in sheep, caused a decreased PCV level and eosinophilia (Dawkins et al., 1989; Buddle et al., 1992; Douch et al., 1996 and Woolaston et al., 1996). Misra et
al. (1996) observed decreased values of haematocrit, haemoglobin, and RBC counts in lambs in relation to nematode and amphistome infection.

Eslami (1997) reported that the GI infections cause to loss and excretion of protein from the intestinal lumen and impact on the protein metabolism in small ruminants. Yadav et al. (1993) observed no significant changes in Hb, PCV level and TSP concentration of Nail and Merino cross-bred sheep experimentally infected with *H. contortus* and opined that such sheep was resilient to the infection. Maiti et al. (1999) recorded that sheep infected with gastro-intestinal parasites sowed reduced Hb and TEC values, whereas the treated group of (Albendazole @ 15mg/kg bw orally with Belamy[R] @ 2.5ml/kg bw I/M on alternate days) had significantly higher level of Hb and TEC value.

In GIP infections, protein losses are marked particularly through the faeces of the host. Previous researches reported that the amount of leaving non-reabsorbable endogenous nitrogen from the ileum of GIP infected sheep can be reached up to 4-5 g N per day (Coop and Kyriazakis, 2001). Dhanalakshmi et al. in 2002 reported that sheep infected with naturally occurring *Strongyle* nematodes had lower level of PCV and lymphocyte count, whereas neutrophil, eosinophil, basophil and monocyte counts were significantly increased. Arora et al. (2003) observed a negative correlation between the intensity of naturally occurring gastro-intestinal nematodosis in sheep and goats and the haemoglobin values.

Abrahams-Sandi et al. (2005) demonstrated an increase in both cellular and humoral response following parasitic challenges, which go on to suggest the increase in the serum globulin. Haemonchosis like ostertagiasis and trichostrongylosis leads to hypoproteinemia and hypoalbuminemia in livestock. Because these GI parasites stimulate the proliferation of intestinal epithelial cells and replacement of abomasal acid-producing cells by immature cells, this consequently leads to the loss of large quantities of serum protein into the gut. As a result, haemodilution which occurs after abomasal haemorrhage can cause relative hypoproteinemia and
hypoalbuminemia (Eslami, 2006 and Angulo-Cubillan et al., 2007). Furthermore, in chronic haemonchosis sever hypoproteinemia has been reported by Allonby (1974) and Abbott (2007).

Mir et al. (2007) described decreased concentrations of total protein in sheep during haemonchosis. Decrease in total serum proteins may be attributed to haemodilution, a compensatory mechanism for the abomasal haemorrhages caused by the invading larvae and later on due to loss of large quantities of serum proteins into the gut and consequent increased fractional catabolic rate of albumin.

Hassanpour et al. (2011) reported that there was not a significant correlation between the faecal egg counts and faecal nitrogen losses in sheep, as well as, the evaluating of faecal CP % (crude protein) is not a good indication for determining the load of parasite infection in small ruminants.

The concentrations of serum albumin, packed cells volume, erythrocyte sedimentation rate were significantly increased (P<0.05), while the concentration of haemoglobin, total erythrocyte count, total serum proteins were significantly decline (P<0.05) in Haemonchus infected animals. Finally, it was concluded that decreased hemoglobin concentration, total serum proteins total erythrocyte count were important indicators of haemonchosis in sheep and goats (Qamar et al., 2012).

2.4. Histopathological study

Guilhon and Rrionzean (1945) described the pathogenic effect of paramphistome infection that the heavy load of amphistomiasis in the rumen caused chronic rumenities, which manifested by loss of body condition, diarrhoea cessation of rumination and tympani. Alwar (1949) found that edematous inflammation in pyloric region of the abomasum and duodenum with several immature amphistomes attached to the mucosa was the characteristic lesions. Nobel in 1956 observed duodenities, eosinophilic infiltration and penetration of immature flukes into the submucosa and even in the deep muscular layer of duodenum. In case of heavy infections,
the wall of the bile ducts becomes thickened. Charleston (1965) reported deep invasion of muscular layer of abomasal mucosa in sheep by *H. contortus* larvae.

Dow et al. (1967) recorded the changes of liver in experimentally produced fascioliasis in calves. The migrating flukes produced little reaction in the host tissue and in the later stages they became surrounded by macrophages, eosinophils and granular tissue. Early of the flukes into the bile ducts resulted in proliferation of the epithelium producing a granular mucosa. Sharma and Katiyar (1967) observed that *Paramphistomum cervi* attaches to intestine by the acetabulum and possible feeding led to the destruction of villi and desquamation of cells into the lumen. There was inflammatory response with visible thickening of the intestine wall even in acute infections. Posen (1967) reported gastro-intestinal diseases, such as peptic ulcer and ulcerative colitis, to be responsible for enzyme release from affected mucosa.

Griffith (1974) reported that a small nodular lesion, which sometimes developed into a papilloma like outgrowth and monolobular cirrhosis of variable extent, might be present. Kotrla et al. (1976) observed that gastro-intestinal parasite caused marked pathological changes in the liver and rumen in Afghanistan.

The pathogenesis of *H. contortus* infection in lambs under six months of age challenged orally with ten thousand third stage infective larvae is described (Hunter and Meckenzie, 1982). Development of the parasite and its relationship to haematological and pathological changes are discussed, with particular reference to specific cellular mobilizations, and detailed descriptions are given of the haematology and parasitology, gross pathology and histopathology at four, seven, twelve, eighteen, twenty two and thirty five day post infection. Blood et al. (1983) opined that in ruminants, paramphistomosis is associated with diarrhoea, loss of body condition, rough hair coat, dullness, weakness, loss of appetite, intestinal
hemaeorrhage, anemia, reduced milk production and intermandibular swelling.

Dwivedi et al. (1997) reported that pathological lesions caused by *P. cervi* were mostly confined to mucosal thickening of the small intestine without petechial haemorrhage. Diaw et al. (1998) reported that fascioliasis causes enormous economic losses in livestock all over the world and these losses are due to reduction in milk and meat production, condemnation of liver, loss of draught power, reproductive failure and mortality.

Ozer et al. (2003) reported that fascioliasis is an important helminthic disease caused by two trematodes namely, *Fasciola hepatica* and *Fasciola gigantica*. The infective metacercariae usually migrate the liver capsule and hepatic tissue. This migration usually cause direct trauma with haemorrhages, necrosis and subsequent granulation tissue end by liver cirrhosis.

Mir et al. (2007) evaluated the clinicopathological response of native sheep of Kashmir to blood feeding nematode, *H. contortus*. During the tenure of the study macroscopic lessons were first seen in abomasum. The cardiac regions of infected abomasum had thickened walls and edematous folds and infected gastric mucosa of cardiac region showed white spots. Although marked congestion of haemorrhages were seen in the entire abomasum of infected sheep. No pathological changes were observed in abomasum of uninfected control animals. Mucosal hyperplasia and abundant mucus secreting gastric cells were noted in infected animals. The cellular inflammatory reactions were more marked because of infiltrated eosiniophils, mononuclear cells and plasma cells in the mucosa of *H. Contortus* infected animals. Aziz (2007) observed lesions produced from *S. bovis* as phlebitis and venous thrombosis associated with intimal proliferation, thus interfering with circulation through the liver.

Senlik (2008) reported that parasitic liver affections in meat-producing animals are one of the major factors that reduce national income and cause economic losses, either directly through condemnation of the pathologically
affected livers, or indirectly by their effect on the animal growth and so its meat production.

Al-Kennany et al. (2009) conducted a pathological study on sheep infected with GI parasites. Histopathological section of lymph node of sheep infected with *S. bovis* showed severe depletion in secondary lymph follicles associated with lymphadenitis which represented by proliferation of lymphocytes and infiltration of macrophage as well as congestion of blood vessel in cortex and medulla. Histopathological section of mesentery tissue of the infected sheep revealed presence of severe congestion in arterioles and veinioles, thickness in the wall of arterioles due to presence of vacuole in all layers of arterioles, also thrombophelinitis have been seen associated with presence of cross sections of adult parasites in the lumen. Although liver section of sheep infected with *S. bovis* showed sever congestion of blood vessels perivascular cuffing of lymphocytes (minute granuloma) vascular degeneration and fibrosis in portal area associated with infiltration of mononuclear inflammatory cells. Ijaz et al. (2009) reported that a blood sucking *H. contortus* can suck about 0.05 ml blood per day in ovine. The fourth larval (L₄) and adult stages of this GI worm suck blood and in addition, move and leave wounds that haemorrhage from the abomasal wall of the host.

Nourani et al. (2010) reported that *Cysticercus tenuicollis* is the larval stage of canine tape warm, *Tania hydatigena*. The cysticercoids are developed as fluid-filled cysts and found attached to the omentum, mesentery, liver and peritoneum. Massive invasion and migration of the cysticercoids through the liver tissue and encysts on the peritoneal membranes of small ruminants, results in acute severe traumatic hepatitis with haemorrhagic and fibrotic tracts which is known as hepatitis cysticercosis.

Sultan et al. (2010) reported that abomasum is one of the most important sites for living bursate nematodes belonging to the family trichostrongylidae in small ruminants, because it is the location site for
three pathogenic species of GI nematodes e.g., *Haemonchus sp.*, *Teladorsagia sp.*, *Ostertagia sp.* and *Trichostrongylus sp.*, meanwhile it was shown that gastro-intestinal nematodes could be harmful to the health mortalities, reduce weight gain and other production losses.

Uddin et al., (2010) conducted a pathological study of amphistomiasis in small ruminants. The gross pathological changes due to amphistomiasis caused by adult flukes revealed the denudation of rumen papillae. There were no marked changes in the esophagus, reticulum and omasum. There was slight thickening and corrugation of the abomasal wall caused by immature amphistome infection. The mucosa of the upper part of duodenum was corrugated, thickened, congested and covered with blood stained mucus with the presence of numerous immature worms. The histopathological changes caused by mature amphistomes in infected rumen revealed the excessive keratinization, hyperplasia of the epithelial tissue, edema and fibroblastic proliferation in the sub-mucosa. There were no remarkable changes in the reticulum, except edema in the sub-mucosa. The histopathological changes due to the immature amphistomes in the duodenum revealed the sloughing off the epithelial tissue, infiltration of mononuclear cells in the lamina propria and sub-mucosa. In some cases, glandular hyperplasia and formation of microabscesses was observed in infected animals.

Pathological changes were observed grossly and confirmed histopathologically in the small intestine and rumen of sheep infected with *Paramphistomum cervi* in Kashmir valley (Tariq et al., 2011). Pathological lesions were mostly confined to small intestine, especially duodenum and jejunum in infected sheep. The infection caused by the gastro-intestinal parasite in the rumen was increased cornification of the stratum corneum, atrophy, severe infiltration and thickening of mucosa occurs in the rumen papillae, but no ulceration was found. According to the number of worms, changes varied from a localized enteritis and villous atrophy in the duodenum in light infections to severe destructions of the mucosa extending into most of the jejunum in heavy infections. Although mucosa at places
was found congested with petechial haemorrhages. The number of flukes and their location in the gastro-intestinal tract were observed and the population of globule leucocytes was recorded. They also reported that the immature forms of *P. cervi* caused more severe damage in the duodenal tissue, where as adult forms inflicted mild tissue damage in the rumen of sheep.

Bahrani et al. (2012) studied on pathophysiology of sheep glands infected with gastro-intestinal helminths. Liver section of sheep infected with gastro-intestinal nematodes showed free space in the parenchyma and sever congestion of blood vessels per vascular cuffing of lymphocytes (minute granuloma) vascular degeneration and fibrosis in portal area associated with infiltration of mononuclear inflammatory cells.

Hanaa et al. in 2012 conducted a study to investigate the pathological effect of gastro-intestinal parasites in small ruminants in Egypt. They reported that histopathologically, liver tissues with fascioliasis showed 2.6% acute hepatitis, 9% chronic catarrhal cholangio-hepatitis with hyperplasic biliary epithelium including granulome formation in 4% of them. As well as biliary epithelium was greatly hyperplastic forming papillomatous projections with goblet cell hyperplasia. While liver tissues infested with *C. Tenuicollis* revealed presence of 2.6% acute hepatitis with cyst formation, 8% chronic cholangio-hepatitis.

Tehrani et al. (2012) conducted a histopathological study of *H. contortus* in Herrik sheep abomasum in Iran. In this investigation, on microscopic examination, petechial haemorrhage in the abomasal mucosa, infiltration of mononuclear cells and eosinophils in gastric glands, periglandular hyperemia and haemorrhage, mucous gland hyperplasia, connective tissue proliferation and necrosis was observed. In mixed abomasal infection with *Haemonchus* sp. and *Ostertagia* sp., mucosal hyperplasia and increased mucous glands and sometimes cystic glands were also observed.
2.5. Anthelmintic activity of plant extract

Naqvi et al. (1991) examined the anthelmintic activity of *Artemisia scoparia* and reported the anthelmintic activity of flower hexane extract of *Artemisia scoparia*. Tandon et al. (1997) studied the in vitro anthelmintic activity of root tuber extract of *Flemingia vestita* against *Paramphistomum*. The treatment of gastro-intestinal parasites with the crude extract (50 mg/ml) in PBS revealed complete immobilization of the trematode in about forty three minutes.

Beriajaya et al. in 1998 reported the in vitro anthelmintic activity of *Zingiber purpureum* infusion and extract on adult worms of *H. contortus*. Niezen et al. (1998) studied the establishment and fecundity of *Teladorsagia* (Ostertagia) *circumcincta* and *T. colubriformis* in lambs fed lotus (*Lotus pedunculatus*) or Perennial rye grass (*Lolium perenne*) in New Zealand. They reported that lambs fed lotus had lower faecal egg counts (*P < 0.0001*) and lower *Teladorsagia* (Ostertagia) *circumcincta* burdens (*P < 0.0001*), fewer female *O. circumcincta* (*P < 0.0001*) and higher faecal dry matter (*P < 0.0001*) than lambs fed rye grass, but numbers of *T. colubriformis* nematodes were not affected.

Akhtar et al. in 1999 studied the anthelmintic activity of *Chenopodium album* against sheep nematodes. The aqueous and ethanolic extracts of *C. album* showed significant percentage of egg reduction. Akhtar et al. (2000) reviewed the anthelmintic activity of medicinal plants with particular reference to their use in animals in the Indo-Pak sub-continent. According to them a wide variety of plants are available in the Indo-Pak sub-continent which possess anthelmintic activities.

Athanasiadou et al. (2000) studied the possible direct anthelmintic effect of a condensed tannins (CTs) extract (Quebracho extracted from *Schinopsis*) on the population and fecundity of the *T. colubriformis*. In the treated sheep, the worm burdens and EPG of faeces per worm were reduced by 30% in comparison to control sheep. In 2001 the same authors studied the possible direct anthelmintic effects of CT from Quebracho towards
different ovine GI nematode larvae (*H. contortus*, *T. circumcinata* and *T. vitrinus*). They in 2005 tested the direct anthelmintic effects of bio-active forages against *T. colubriformis* in grazing sheep. They found that sheep grazing on lotus tended to have lower FEC in comparison to sheep grazing on rye grass and white clover (*P* = 0.06), whereas daily faecal output was higher in sheep grazing lotus compared to those grazing on the other forages (*P* <0.05).

Kato et al. (2000) studied the efficacy of *Chenopodium ambrosioides* as an anthelmintic for treatment of GI nematode parasites in lambs. They observed that oral administration of the oil produced by the plant, has no toxic effect. However, they observed a significant reduction in the number of Trichostrongyle egg per gram of faeces in treated lambs in comparison to control lambs.

Al-Qarawi et al. (2001) examined the anthelmintic activity of *Calotropis procera* in sheep that had been infected experimentally infected with *H. contortus* larvae. Infected sheep were treated with single oral doses of 0.01 ml or 0.02 ml/kg body weight of *C. procera*. They observed that egg production was significantly reduced, but not completely suppressed, and fewer adult *Haemonchus* worms were found in the abomasum. Although the appetite improved, the haemoglobin concentration and serum copper, iron and zinc levels were still reduced after treated with *C. procera*. *Calotropis procera* showed a concentration-dependent larvicidal activity within twenty minute of application.

Iqbal et al. (2001a) examined in vitro inhibitory effects of *Sorghum bicolor* on hatching and moulting of *H. contortus* eggs. Hatching of *H. contortus* eggs on day two post treatment (PT) in *Sorghum bicolor* extract treated cultures was 5.8% whereas, it was 69.8% in cultures treated with distilled water. Iqbal et al. (2001b) also carried out the in vitro anthelmintic activity of *Allium sativum*, *Zingiber officiniae*, *Cucurbita mexicana* and *Ficus religiosa* methanol extracts. They revealed that *Z. officiniae* killed all the *H. contortus* within two hours PT. *A. sativum* and *C. mexicana* extracts were
equally effective at two hour and four hour post exposure; by six hour post exposure, however, the former was also 100% effective. *C. mexicana* could not kill all the worms and was only 83.4% effective. *F. religiosa* was 100% effective by four hour post exposure and was as good at *A. sativum* and *Z. officinaie* by six hour post exposure. Iqbal et al. (2002) also reported positive anthelmintic activity of the tannins against the helminth parasites of ruminants. Iqbal et al. in 2003 reviewed the herbal dewormers in livestock and laid emphasis on the use of herbal medicine as new and challenging means of parasite control in the animals. Iqbal et al. (2004) examined the in vitro and in vivo anthelmintic activity of *Artemisia brevifolia* in sheep and they observed that, although, *A. brevifolia* whole plant possesses anthelmintic activity against nematodes, it is not comparable with levamisole. Iqbal et al. (2005) also examined the anthelmintic activity of *Calotropis procera* (Ait) Ait. flowers in sheep through in vitro and in vivo studies and revealed significant anthelmintic effects (P<0.05) of crude aqueous extract (CAE) and crude methanolic extracts (CME) on live *H. contortus* as evident from their mortality or temporary paralysis. Iqbal et al. (2006a) investigated dose and time dependent in vitro anthelmintic activity of *Butea monosperma* seeds against trichostrongylid nematodes in naturally infected sheep. They observed the maximum reduction (78.4%) in EPG of faeces on day ten after treatment with 3 g/kg bw. Iqbal et al. (2006 b) also examined in vivo anthelmintic activity of ginger against GI nematodes of sheep and showed that crude powder (CP) and CAE of ginger exhibited a dose and a time dependent anthelmintic activity with respective maximum reduction of 25.6% and 66.6% in EPG in faeces on day ten PT. Iqbal et al. (2006c) reported the in vitro and in vivo anthelmintic activity of crude aqueous and methanolic extracts of *Swertia chirata* against GI nematodes of sheep and revealed significant anthelmintic activity (P > 0.05).

Brelin in 2002 evaluated the Neem leaves (*Azadirachta indica*) as an alternative anthelmintic for helminth control. They observed that fresh neem leaves significantly reduced the numbers of *H. contortus* in the abomassum of the treated sheep. Chitwood (2002) investigated the phytochemical based
strategies for nematode control. Higher plants have yielded of active compounds, including polythienyls, isothiocyanates, glucosinolates, cyanogenic glycosides, alkaloids, terpenoids, simple and complex phenolics and several other classes. These natural products are very much active against mammalian parasites and can serve as useful sources of compounds for examination of activity against nematodes. Costa et al. in 2002 reported the ovicidal effect of *Mangifera indica* L. seed ethanolic and hexane extracts at 0.08, 0.4, 2.0, 10.0 and 50.0 mg/ml on *H. contortus* using the egg hatch test in sheep and goats.

Githiori et al. (2002) studied the anthelmintic activity of preparations derived from *Myrsine africana* and *Rapanea melanophloeas* against *H. contortus* of sheep. They observed no significant reduction in faecal egg counts with any of the concoctions at any of the doses tested. They (2003) also evaluated the anthelmintic efficacy of the plant, *Albizia anthelmintica* water extracts against *H. contortus* of sheep and observed significant reduction in faecal egg counts in lambs after the treatment with the extracts. The same authors (2004) evaluated the anthelmintic properties of some plants against *H. contortus* infections in sheep and observed significant reduction in faecal egg count and total warm count in lambs after feeding them with the plant preparations from *Olea europaea*, *Annona squamosa*, *Ananas cosmosus*. Githiori (2004) evaluated anthelmintic efficacy of seven plants in lambs infected with *H. contortus* and observed no significant reduction in FEC for any of the treated groups in comparison to the control. Githiori et al. in 2006 reviewed the use of plants in novel approaches for control of GI helminths in livestock with emphasis on small ruminants, and interpreted that plant remedies have in most instances caused reductions in the level of parasitism less pronounced than that of anthelmintic drugs, and only rarely has reductions similar to that caused by synthetic anthelmintics been achieved.

Ketzis et al. (2002) studied the anthelmintic efficacy of *C. ambrosioides* oil as treatment for *H. contortus* and mixed adult nematode infection. Their study revealed that short term treatment of individual animals with the
plant or oil was not effective in reducing the number of nematode adults or eggs. However, under in vitro studies, the oil did reduce viability of eggs. Pessoa et al. (2002) examined the anthelmintic activity of essential oil of *Ocimum gratissimum* L., and eugenol against *H. contortus*. They observed mean inhibition percentage on egg hatch of *H. Contortus* using different concentrations of the essential oil at 0.50 and 1.0% concentrations compared with 1.0% thiabendazole, the positive control.

Alawa et al. (2003) examined the in vitro anthelmintic activity of *Vernonia amygdalina* and *Annona senegalensis* extracts using *H. contortus* eggs and reported that the extract of *V. amygdalina* did not show any significant activity at concentrations up to 11.2 mg/ml. However, the extract of *A. senegalensis* showed significant (P < 0.001) reduction in egg hatch at a concentration of 7.1 mg/ml.

Lateef et al. (2003) explored the in vitro and in vivo anthelmintic activity of *Adhatoda vasica* in comparison to levamisole. The in vitro studies revealed anthelmintic effects (P≥0.05) of crude aqueous extracts (CAE) and crude methanol extracts (CME) of *A. vesica* on live *H. contortus* as evident from their mortality. Under in vivo studies, roots of *A. vesica* were administered as crude powder (CP), CAE and CME to sheep naturally infected with mixed species of gastro-intestinal nematodes. Maximum reduction (37.4%) in egg per gram (EPG) was recorded in sheep treated with CAE @ 3 g Kg⁻¹ body weight on day ten post-treatment (PT) followed by CP @ 2 g (33.05%) and CME @ 3 g (25.6%) on day fourteen PT. It was found that *A. vasica* roots possess anthelmintic activity against nematodes, yet not comparable with levamisole (97.8 to 100% reduction in EPG).

Min and Hart (2003) evaluated the effect of condensed tannin extracted from various plants on adult nematodes and their larval stages in sheep and goat and postulated that the condensed tannin decrease the viability of the larval stages of the parasites and also interfere with the parasite egg hatching and development to infective larvae. Singh et al. (2003) recorded the anthelmintic efficacy of methanolic, chloroform and
aqueous extracts of *Allium sativum, Areca catuha, Azadirachta indica, Butea monosperma, Psoralea corylifolia* and *Vermonia anthelmintica* in comparison to fenbendazole against *H. contortus* under in vitro conditions. Singh et al. (2004) examined the efficacy of some ethno medicinal plants against *H. contortus* and observed highest anthelmintic activity in methanolic extracts of *Mallotus philippensis*.

Ademola et al. (2004) studied the direct in vitro and in vivo anthelmintic activity of ethanolic and aqueous extracts of *Khaya senegalensis* against GI nematodes of sheep and reported the decrease in viability of nematode larvae after the treatment. Ademola et al. (2005) also carried out the in vitro and in vivo study to validate the efficacy of *Spondias mombin* extracts towards different ovine GI nematodes and revealed anthelmintic action on *Haemonchus* spp., *Trichostrongylus* spp., *Oesophagostomum* spp., *Strongyloides* spp. and *Trichuris* spp. Gathuma et al. (2004) examined the efficacy of *Myrisine africana, Albizia anthelmintica* and *Hilderbrantia sepalosa* herbal remedies against mixed natural sheep helminthiasis. Their findings indicate that all the herbal remedies had some efficacy against both nematodes and *Moniezia* species.

Singh et al. (2005a) examined the anthelmintic activity of methanolic extract of leaves of *Bauhinia variegata* at different concentrations against *H. contortus* and reported significant anthelmintic activity at five hour post incubation. They (2005b) also examined anthelmintic activity of methanol extract of flowers of *Tagetes patula* at different concentrations against *H. contortus* and reported significant anthelmintic activity at five hour post incubation. The researchers (2005c) studied in vitro screening of *Thuja orientalis* leaf extract for anthelmintic activity against *H. contortus* at 1000, 1500, 2000 µg/ml concentrations for five hour at 38.5°C. They reported that methanolic ether extract possess an anthelmintic effect and may be used in the development of a herbal drug against *H. contortus*.

Hounzangbe-Adote et al. (2005) carried out the study on in vivo effects of fagara leaves on sheep infected with GI nematodes. The effect of
consumption of fagara leaves on infected sheep with GI nematodes was associated with a decrease in egg excretion and a significant reduction in the fertility of female worms, without changes in the worm number. Khalid et al. (2005) in Bangladesh carried out a study on effects of indigenous medicinal plants (neem and pineapple) aqueous extracts against GI nematodiasis in sheep. They observed a significant (P<0.01) reduction of EPG count after seven, fourteen, twenty one and twenty eight days post-treatment.

Chandrawathani et al. (2006) evaluated the anthelmintic effect of neem (*Azadirachta indica*) on nematode parasites of sheep. The results of faecal nematode egg count showed that there was no significant difference between the control and treated group (p=0.081). However, worm burden estimations showed that the number of parasites was significantly higher in the control group in comparison to the treated group (P<0.05). This result of the study indicated that *A. indica* had an effect on reduction of worm numbers in sheep.

Costa et al. (2006) studied the anthelmintic activity of *Azadirachta indica* A. Juss against sheep GI nematodes and reported that leaves of *A. indica* had no anthelmintic effect. Jabbar et al. in 2006 carried out an inventory of the ethnobotanicals used as anthelmintics. They used twenty nine plants to control helminthiasis in ruminants. Lange et al. (2006) studied the effect of *Sericea lespedeza* (*Lespedeza cuneata*) on natural and experimental *H. contortus* infections in Lambs in Fort Valley, USA. *S. lespedeza* significantly reduced (67 - 98%) FEC during the time of feeding for both naturally and experimentally infected groups. It also decreased worm numbers, with more of an effect on reducing naturally infected worm burdens.

Maciel et al. (2006) evaluated the ovicidal and larvicidal activity of the seed and leaf extracts of *Melia azedarach* against *H. contortus* and also investigated the type of chemical compounds present in the most active extracts. The ethanolic extracts of seed was the most active on eggs (LC$_{50}$ =
0.36 mg/mL) and the leaf ethanol extract showed the best inhibition of larval development \( \text{LC}_{50} = 9.18 \text{ mg/mL} \). Phyto-chemical analysis of the most active extracts revealed the presence of CT, triterpenes and alkaloids etc.

Monglo et al. (2006) assessed the febendazole (Panacur) and ethanolic leaf extracts from five herbal plants (Annona senegalensis, Anogeissus leiocarpus, Lippia rugosa, Stereospermum kunthianum and Vernonia tonoreana), for egg-inhibition ability as well as toxicity against the infective larval stage (third-instar) of \( H. \text{contortus} \). The eggs and larvae were exposed to different concentrations (0, 0.1, 0.2, 0.4 and 0.8\% (w/v) of the test materials for seven days and one to forty eight hour, respectively. All the test materials induced a significant \( (p<0.01) \) dose-dependent inhibition of egg-hatch and larval mortality.

Eguale et al. (2007a) evaluated in vitro and in vivo anthelmintic activity of crude aqueous and hydro-alcoholic extracts of the ripe fruits of \( Hedera \text{helix} \) on eggs and adult \( H. \text{contortus} \) of sheep. Hydro-alcoholic extract showed better in vitro activity against adult parasites in comparison to the aqueous extract. Significant faecal egg count reduction was detected in sheep treated with both doses of \( H. \text{helix} \) \( (P<0.05) \) on day two PT. On day seven PT significant reduction was detected only for higher dose of \( H. \text{helix} \) \( (P<0.05) \). They (2007b) also studied anthelmintic activity of crude aqueous and hydro-alcoholic extracts of the seeds of \( Coriandrum \text{ sativum} \) on the eggs and adult \( H. \text{contortus} \) of sheep. Both extract of \( C. \text{ sativum} \) inhibited hatching of eggs completely at a concentration less than 0.5 mg/ml. The hydro-alcoholic extract showed better in vitro activity against adult parasites in comparison to aqueous. On day two PT, significant faecal egg count reduction was detected in sheep treated with higher dose of \( C. \text{ sativum} \) \( (P<0.05) \) and albendazole \( (P<0.001) \).

Felix et al. (2007) observed direct anthelmintic effects of tanniferous forages against \( H. \text{contortus} \) and \( Cooperia \text{ curticei} \) in lambs. Individually lambs were fed with chicory \( (Cichorium \text{ intyhus}) \), bird foot trefoil \( (Lotus \text{ corniculatus}) \), and mulberry leaves. Mulberry leaves showed significant anthelmintic activity in lambs at 60\% and 100\% on day seventeen PT and 100\% on day forty one PT. Chicory and bird foot trefoil showed significant antihelminthic activity on day twenty one PT at 60\% and 100\% on day forty one PT.
corniculatus), sainfoin (Onobrychis viciifolia) or a rye grass or lucerne mixture (control) for seventeen days. When compared to the control groups, administration of all tanniferous forages was associated with significant reductions of total daily faecal egg output specific to *H. contortus* (chicory: 89%; birds foot trefoil: 63%; sainfoin: 63%; all tests (P<0.05)) and a tendency of reduced *H. contortus* worm burden (chicory: 15%; birds foot trefoil: 49% and sainfoin: 35% reduction).

Max et al. (2007) investigated the effect of tanniniferous browse meal on faecal egg counts (FEC) and intestinal worm burdens in sheep and goats experimentally infected with gastro-intestinal nematode parasites. They observed that leaves of *Acacia polyacantha* had the highest tannin concentration and were used to test their anthelmintic effect.

Bizimenyera et al. (2008) evaluated the anthelmintic activity of *Peltophorum africanum* extracts against the gastro-intestinal nematodes in sheep. Twenty four male lambs were induced with infections (L$_3$ infective stages) of *H. contortus* (two thousand eight hundred each) and *Trichostrongylus colubriformis* (three thousand five hundred each). After four weeks, the sheep were administered with acetone extracts of *P. africanum* at doses of 50, 500 and 750 mg kg$^{-1}$ and the control group received no treatment. There was no significant (p=0.073) faecal egg count reduction at concentrations of up to 750 mg kg$^{-1}$, or reduction in total worm burden.

Marta et al. (2008) reported that *Annona squamosa* seed extracts showed anthelmintic activity against *H. contortus*. A compound was isolated from ethyl acetate extract, which inhibited the egg hatching of *H. contortus* at 25 mg ml$^{-1}$. The structure of compound was determined as a C$_{37}$ trihydroxy adjacent bistetrahydrofuran acetogenin based on spectroscopic analysis.

Tariq et al. (2008a) evaluated the anthelmintic efficacy of crude aqueous extracts and crude ethanolic extracts of entire *Achillea millifolium* against the gastro-intestinal nematodes of sheep. The faecal egg count reduction assay was used for in vivo studies and worm motility inhibition
assay was used for in vitro studies. In vitro studies revealed significant anthelmintic effects of crude aqueous and ethanolic extracts on live *H. contortus* worms (P<0.05) as evident from their paralysis and/or death at eight hour post exposure. Aqueous extracts of *A. millifolium* resulted in a mean worm motility inhibition of 94.44%, where ethanolic extracts resulted in mean worm motility inhibition of 88.88%. Tariq, et al. (2008b) examined the study was to evaluate the anthelmintic efficacy of *Iris hookeriana* L. against gastro-intestinal nematodes of sheep. A faecal egg count reduction assay was used for an in vivo study and a worm motility inhibition assay was used for in vitro study. The in vitro study revealed anthelmintic effects of aqueous extracts and ethanolic extracts on live *Trichuris ovis* worms (P<0.05) as evident from their paralysis and/or death at eight hour after exposure. In vitro and in vivo studies reveals that *I. hookeriana* showed significant anthelmintic activity against gastro-intestinal nematodes of sheep and has the potential to contribute to the control of gastro-intestinal nematode parasites of small ruminants. Tariq et al. in 2009 observed significant anthelmintic effects of crude aqueous extracts (CAE) and crude ethanolic extracts (CEE) on live adult *H. contortus* worms. However, crude ethanolic extracts were more efficacious than CAE. The oral administration of the extracts in sheep was associated with significant reduction in faecal egg output by the GI nematode parasites. The CEE was as effective as drug-albendazole and demonstrated faecal egg count reduction (FECR) of 90.46% in sheep at 2.0 g kg\(^{-1}\) body weight on day fifteen PT followed by 82.85% FECR at 1.0 g kg\(^{-1}\) bw on day fifteen PT. The CAE showed less activity and resulted in maximum of 80.49% FECR at 2.0 g kg\(^{-1}\) bw. Dosage had a significant (P<0.05) influence on the anthelmintic efficacy of *A. Absinthium* in ovine nematodes.

Adama et al. in 2009 conducted a study to evaluate *Anogeissus leiocarpus* leaf and *Daniellia oliveri* stem barks as effective remedy for gastro-intestinal parasites. Anthelmintic activity of these extracts on eggs, first stage larvae and adults of *H. contortus* was examined by in vitro tests. The
results showed that the *D. oliveri* stem bark extract was more ovicidal and larvicidal than *A. leiocarpus* leaves extracts.

AL-Shaibani et al. (2009) examined the anthelmintic activity of *Fumaria parviflora* against gastro-intestinal nematodes of sheep through egg hatch and larval development tests (in vitro) and faecal egg counts reduction test (in vivo). In vitro studies revealed that crude aqueous and crude methanolic extracts at the concentration of 3.12, 6.3, 12.5, 25.0 and 50.0 mg/ml exhibited ovicidal and larvicidal effects (P<0.05) against the eggs and larvae of gastro-intestinal nematodes. The highest effective dose (ED\textsubscript{50}) value was recorded on the eggs of *Chabertia ovina* (14.45 mg/mL) with aqueous extract; whereas, the lower value was recorded on the eggs of *H. contortus* (9.12 mg/mL) with ethanolic extract. Similarly, the higher LC\textsubscript{50} value was recorded against the larvae of *Strongyloides papillosus* (16.60) and the lower value against the larvae of *H. contortus* (10.23 mg/mL) with aqueous and ethanolic extracts respectively. In vivo studies revealed that experimental animal groups treated with the doses of 200 mg/kg of either aqueous or ethanolic extracts of *F. parviflora* exhibited higher (p<0.05) reduction rate on faecal egg counts (FEC) in comparison to un-treated groups (negative control).

Bachaya et al. (2009) evaluated the anthelmintic activity of *Terminalia arjuna* bark. Lethal concentration (LC\textsubscript{50} values) of methanolic extract of *T. arjuna* bark in egg hatch and larval development tests against *H. contortus* ova and larva were found to be 645.65 and 467.74 μg mL\textsuperscript{-1}, respectively. In adult motility assay, efficacy of the bark extract was evident by the mortality of *H. contortus* at different hours post exposure. In vivo results revealed maximum (87.3%) egg count reduction (ECR) in sheep treated with crude methanolic extract @ 3 g kg\textsuperscript{-1} body weight on day eleven post-treatment.

Maphosa et al. in 2010 evaluated the crude aqueous extracts of leaves of *A. ferox* and *L. leonurus* and roots of *E. elephantine* for anthelmintic activity. Eggs and larvae of *H. contortus* were incubated at 25°C in aqueous extracts at concentrations of 0.625–20 mg/ml for forty eight hour and seven
days for the egg hatch and larval development assays respectively. Inhibition of egg hatching and larval development increased significantly (P<0.05) with increasing concentrations of the crude extracts. *E. elephantina* and *L. leonurus* extracts had 100% egg hatch inhibition at concentration as low as 2.5 mg/ml and 1.25 mg/ml respectively, whereas extracts of *A. ferox* had 100% inhibition at concentrations of 20 mg/ml. At the lowest concentration tested (0.625 mg/ml), *E. elephantina* inhibited egg hatching is greater than 96% and this was comparable to albendazole at the same concentration. However, *E. elephantina* and *L. leonurus* also totally inhibited larval development at concentrations of 1.25 mg/ml.

Bandh et al. in 2011 assessed the in vitro anthelmintic effects of crude methanolic extracts of *Nepeta cataria* on live *H. contortus* worms (P > 0.05) as evident from their paralysis and/or death at eight hour after exposure. The in vivo anthelmintic activity of the extracts infected with gastro-intestinal nematodes demonstrated a maximum (73.69%) egg count reduction treated with methanolic extracts at 2 g kg\(^{-1}\) body weight on day fifteen after treatment.

Buttle et al. (2011) observed that the soluble fraction of papaya latex had a potent in vivo effect on the abomasal nematode *H. contortus*, but not on the small intestinal nematode *T. colubriformis*. This effect was dose dependent and at tolerated levels of gavage with papaya latex (117μm of active papaya latex supernatant for four days), the *H. contortus* worm burdens were reduced by 98%. However, repeated treatment, daily for four days, was more effective than a single dose, but efficacy was not enhanced by concurrent treatment with the antacid cimetidine.

Elango et al. (2011) reported the antiparasitic activities of leaf hexane, chloroform, ethyl acetate, acetone and methanol extracts of *Aegle marmelos, Andrographis lineata, Andrographis paniculata, Cocculus hirsutus, Eclipta prostrata* and *Tagetes erecta* against the sheep fluke *Paramphistomum cervi*. All plant extracts showed moderate toxic effect on parasites after twenty four hour of exposure; however, the highest parasitic activity was found in ethyl
acetate extract of *A. paniculata*, *C. hirsutus*, methanol extracts of *A. marmelos*, *A. lineata*, and *E. prostrata* against the *P. cervi* ($\text{LC}_{50}=360.17$ ppm).

Jaliwala et al. (2011) conducted a study to evaluate the anthelmintic activity of *Argemone mexicana* aqueous and alcoholic extracts. Both alcoholic and aqueous extracts has shown significant anthelmintic activity in comparison to standared drug albendazole. The experiment indicated the potential usefulness of *Argemone mexicana* L. against helmintic infections. Lavanya et al. in 2011 used the seeds of *Brassica juncea* and flower of *Brassica oleracea* as an anthelmintic. However, hydroalcoholic extract of *Brassica juncea* and *Brassica oleracea* showed more prominent anthelmintic activity.

Kamaraj and Rahuman (2011) conducted a study to assess the efficacy of leaf, bark, and seed ethyl acetate, acetone and methanol extracts of *Andrographis paniculata*, *Anisomeles malabarica*, *Annona squamosa*, *Datura metel* and *Solanum torvum* were tested against the parasitic nematode of small ruminants *H. contortus* using egg hatch assay (EHA) and larval development assay (LDA). All plant extracts showed parasitic effects after forty eight and exposure for egg hatching and LDA, respectively. However, 100% egg hatching and larvicidal inhibition were found in the methanol extracts of *A. paniculata*, *A. squamosa*, *D. metel*, and *S. torvum* at 25 mg/ml and the effect was similar to positive control of albendazole (0.075 mg/ml) and ivermectin (0.025mg/ml) against *H. contortus*, respectively. The result of EHA showed the ED$_{50}$ of methanol extracts of *A. paniculata* and *D. metel*, which were 2.90 and 3.08 mg/ml, and in larval development assay, the ED$_{50}$ was 4.26 and 3.86 mg/ml, respectively.

Macedo et al. (2012) conducted a study to evaluate the effect of decoctions of *Lantana camara*, *Alpinia zerumbet*, *Mentha villosa* and *Tagetes minuta* on *Haemonchus contortus* by two in vitro tests. Effects of increasing concentrations of lyophilized decoctions (0.31 to 10mg/ml) were assessed using the egg hatch test. The decoctions were tested in the larval artificial
exsheathment assay. Third stage larvae ($L_3$) were exposed to 0.31 mg/ml $A.\ zerumbet$ and $M.\ villosa$ decoctions and 0.62 mg/ml $T.\ minuta$ and $L.\ camara$ decoctions for three hour and then exsheathment procedure at ten minute intervals. An inhibitor of tannins, polyvinyl polypyrrolidone, was also used to study if tannins were responsible for the inhibitory effect on hatching and exsheathment of larvae. $A.\ zerumbet$, $M.\ villosa$ and $T.\ minuta$ showed a dose-dependent effect in the egg hatch test, which did not disappear after the addition of polyvinyl polypyrrolidone but no effect was observed for $L.\ camara$ in the egg hatch test. The decoctions inhibited the process of larval exsheathment, which may be related to tannin action because the addition of polyvinyl polypyrrolidone reversed the inhibitory effect. $A.\ zerumbet$, $M.\ villosa$ and $T.\ minuta$ decoctions showed inhibitory activity on larvae hatching and exsheathing.

Ferreira et al. (2013) conducted a study to evaluate the in vitro anthelmintic effects of $Annona\ muricata$ aqueous leaf extract against eggs, infective larvae and adult forms of parasitic nematode $H.\ contortus$. At higher doses, $A.\ muricata$ extract showed 84.91% and 89.08% of efficacy in egg hatch test (EHT) and larval motility test (LMT), respectively. In the adult worm motility test, worms were completely immobilized within the first six to eight hour of nematode exposition to different dilutions. Phytochemical analysis indicated the presence of phenolic compounds in $A.\ muricata$ aqueous leaf extract which may be responsible for the anthelmintic effects.

Molla and Bandyopadhyay (2013b) reported anthelmintic activity of crude aqueous and methanolic extract of $Psidium\ guajava$ against $H.\ contortus$. Effect of crude aqueous and methanolic extracts of $P.\ guajava$ was dose-dependent. Highest mortality (100%) of worms have been observed in eight hours post-exposure @ 50 mg/ml of crude methanolic extract. The crude methanolic extract of $P.\ guajava$ exhibited greater anthelmintic activity against the parasite than the aqueous. Crude methanolic extract ($LC_{50}= 4.40\text{mg/ml}$) was found higher inhibitory effects compared with that of aqueous extract ($LC_{50}= 5.45\text{mg/ml}$) on egg hatching.