

**Epidemiological and Therapeutic Studies on
Gastrointestinal Helminth Parasites of Cattle in North
Kashmir**

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(2012-V-186-M)



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Technology of Kashmir**

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**Epidemiological and Therapeutic Studies on
Gastrointestinal Helminth Parasites of Cattle in North
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Dr. Aiman Ashraf
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Thesis

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**Master of Veterinary Sciences
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2014



Dedicated

To my

Beloved parents



Sher-e-Kashmir
University of Agricultural Sciences and Technology of Kashmir
Division of Veterinary Parasitology, Shuhama Campus, Srinagar
190006

Certificate – I

This is to certify that the thesis entitled, **“Epidemiological and Therapeutic Studies on Gastrointestinal Helminth Parasites of Cattle in North Kashmir”** submitted in partial fulfillment of the requirements for the award of the degree of **Master of Science in Veterinary Sciences (Veterinary Parasitology)**, to the **Faculty of Post-graduate Studies, Sher-E-Kashmir University of Agricultural Sciences and Technology of Kashmir** is a record of bonafide research work carried out by **Dr. Aiman Ashraf (Regd. No. 2012-V-186-M)** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

It is further certified that information received during the course of investigation has duly been acknowledged.

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ABSTRACT

A survey on the prevalence of gastrointestinal helminth parasites in locally reared cattle was conducted in north Kashmir (Baramulla, Kupwara & Bandipora districts) for a period of one year from July 2013 to June 2014. A total of 1126 faecal samples were examined of which 674 (59.86%) were found positive for one or more gastrointestinal helminth parasite. Overall prevalence of trematodes, cestodes and nematodes was found to be 11.63, 4.44 and 53.02 per cent, respectively. Paramphistomes (7.10%) were the most prevalent trematodes followed by *Fasciola* spp. (4.53%) and *Dicrocoelium* spp. (0.27%). Among cestodes the only genus reported was *Moniezia* spp. with percentage prevalence of 4.44 per cent. Among nematodes, the prevalence of strongyle worms was found highest (49.91%) followed by *Trichuris* spp. (3.64%) and *Strongyloides* spp. (2.04%). Seasonal variation revealed significantly ($P < 0.05$) highest prevalence of gastrointestinal helminth parasites during spring (68.21%) followed by autumn (67.50%), summer (55.59%) and winter (48.21%). Overall young cattle had significantly ($P < 0.05$) higher prevalence (68.12%) than adult animals (55.10%). But the prevalence of trematodes was found significantly ($P < 0.05$) higher in adults (14.69%) in comparison to young animals (6.33%). Overall gastrointestinal helminth parasites were found non-significantly ($P > 0.05$) higher in females

(60.56%) as compared to males (58.24%) but the prevalence of paramphistomes was found significantly ($P < 0.05$) higher in females (8.14%) in comparison to males (4.70%). The prevalence of *Dicrocoelium* spp. and all the nematodes was found non-significantly ($P > 0.05$) higher in males as compared to females. Total of 195 samples were examined by quantitative examination to determine the parasitic load. EPG ranged from 0-400 and an average EPG was found to be 177.44 ± 6.29 . Highest EPG was recorded in spring (231.11 ± 14.15) followed by summer (211.11 ± 11.56), autumn (148.00 ± 11.15) and winter (132.73 ± 8.32). The variation was statistically significant ($P < 0.05$) between summer and autumn, summer and winter, autumn and spring, winter and spring. Significantly ($P < 0.05$) higher EPG was recorded in young cattle (195.71 ± 9.85) in comparison to adults (167.20 ± 89.60). Significantly ($P < 0.05$) higher EPG was found in females (189.84 ± 7.91) as compared to males (153.73 ± 9.82). On coprocultural examination, *Haemonchus* spp. (65%) was found to be most predominant strongyle worm followed by *Bunostomum* spp. (20%) and *Trichostrongylus* spp. (15%). On therapeutic studies, ivermectin and fenbendazole were found to be 100 per cent effective against nematode infection (strongyle worms) on 8th and 14th day post treatment. Oxyclozanide was found to be 100 per cent effective against trematode (*Fasciola* spp. and Paramphistomes) infection on 8th, 14th and 28th day post treatment.

Key words: Prevalence, therapeutics, gastrointestinal helminths, cattle, Baramulla, Kupwara, Bandipora districts (J&K)

Signature of Student
Dated. _____

Signature of Major Advisor
Dated _____

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Chapter – 1

INTRODUCTION

Livestock sector plays an important role in Indian economy and is an important sub-sector of Indian Agriculture. The value of output from livestock sector at current prices was about 4,59,051 crore during 2011-12 which is about 24.8 per cent of the value of output from total agricultural and allied sector at current price and 25.6 per cent at constant prices (2004-05) (Annual Report, DAHD, Ministry of Agriculture, GOI, 2012-13). The value of output of milk was 3,05,484 crore in 2011-12, which is higher than the value of output of paddy and wheat. The value of output from meat at current prices in 2011-12 was 83,641 crore (Annual Report, DAHD, Ministry of Agriculture, GOI, 2012-13). Animal husbandry and dairying activities play an important role in national economy and in socio-economic development of the country. These activities have contributed to the food basket, nutrition security, and household income of the farmers and play a significant role in generating gainful employment in the rural areas, particularly among the landless, small and marginal farmers and women, besides providing cheap and nutritious food. Livestock are the best insurance for farmers against vagaries of nature like drought and other natural calamities. This is the sector where the poor contribute to growth directly instead of getting benefit from growth generated elsewhere. The overall growth rate in livestock sector is steady and is around 4-5 per cent and this has been achieved despite the fact that investment in this sector is not substantial. The ownership of the livestock is more evenly distributed with landless labourers and marginal farmers owning bulk of livestock. The progress in the sector results in balanced development of the rural economy particularly in reducing the poverty amongst the weaker sections. Farmers of marginal, small and semi-medium operational holdings (area less than 4 hectare) own about 87.7 per cent of the livestock. (Annual Report, DAHD, Ministry of Agriculture, GOI, 2012-13). Hence development of livestock sector would result in more inclusive growth and development of country's economy.

The Indian subcontinent possesses the largest livestock population in the world. Cattle population in India is about 199.1 million (Annual Report, DAHD, Ministry of Agriculture, GOI, 2012-13) which is about 14 per cent of the world cattle population (1428.7 million). The cattle population in Jammu & Kashmir is 34.43 lakh as per 18th All India livestock census of 2007. Milk is the primary source of income from cattle rearing in India but beef production is also picking up albeit slowly. India stands 5th in the ranking of top meat producing countries of the world with a production of 6.4 million tons of meat in 2012-13 of which cattle contribute 31 per cent (APEDA, Ministry of Commerce & Industries, GOI, 2013). India ranks first in the world in milk production, which has gone up from 53.9 million tonnes in 1990-91 to 127.9 million tonnes in 2011-12. The per capita availability of milk has also increased from 176 grams per day in 1990-91 to 290 grams per day in 2011-12. This is comparable with the world per capita availability of milk at 289.31 grams per day for 2011 (Economic Survey, Govt. of India, 2012-13). In Jammu & Kashmir, the per capita availability of milk is 378ml/day (NDDB Statistics, 2013). On the other hand, as per dietary guidelines by ICMR, the milk requirement is 300 ml/day (ICMR, 2002). This may indicate that the production is sufficient to meet minimum needs but the production is not at all optimum given the huge cattle resources India possesses. The productivity of the domesticated animals in India is low due to many factors like poor genetic potential, adverse climatic conditions and less availability of feed, fodder and pastures throughout the year. This low production is further aggravated by various clinical and sub clinical diseases caused by various bacteria, viruses and parasites.

The parasitic infections especially the gastrointestinal parasitism is present more often as subclinical infection which causes very huge economic losses without actually been noticed clearly. The economic losses are inflicted through mortality, morbidity, reduced feed conversion ratio, reduced weight gain, decreased fertility, retarded growth, inefficiency of production and by the way of costs incurred upon management and treatment of the disease. In India, the

economic losses due to helminth diseases in cattle have been estimated to be millions of rupees (Shan and Chaudhry., 1995).

Among the parasitic diseases prevalent in Indian livestock, the trematode disease fasciolosis is widely spread and has been reported from both hilly and plain areas. In India the incidence of fasciolosis ranges from 30-80 per cent (Bhatia *et al.*, 1989; Rai *et al.*, 1996). There were 195 outbreaks of fasciolosis in cattle reported in the year 2011-12 directly affecting more than 5 lakh animals (Annual Report, DAHD, Ministry of Agriculture, GOI, 2012-13). Worldwide losses in animal productivity due to fasciolosis were conservatively estimated at over US\$ 3.2 billion per annum thus causing huge losses to agricultural communities and livestock industries all over the globe (Spithill *et al.*, 1999). Fasciolosis causes heavy losses both in cattle & sheep. It often leads to poor carcass quality, liver condemnation, reduced milk yield and reproductive failures due to morbid condition and mortality (Gupta and Singh., 2002).

Next to fasciolosis, paramphistomosis is a major trematode disease of cattle. Heavy losses are incurred especially by immature paramphistomosis. As the name implies, the disease in acute form is caused by immature stages which are embedded in the mucosa of small intestines and are plug feeders, drawing pieces of mucosa into the suckers which pinch them off causing necrosis and haemorrhage. It causes severe enteritis characterised by foetid diarrhoea, rapid emaciation and high mortality.

Among cestodes, *Moniezia* spp. has been reported to be most prevalent (Pandit *et al.*, 2004; Singh *et al.*, 2008; Bushra *et al.*, 2013). Although light infections are of little importance but in heavy infections, the intestine may be virtually a solid mass of tapeworms and they can cause unthriftiness and diarrhoea.

Gastrointestinal nematodiosis is caused due to either a single or multiple nematode species and it is regarded as one of the major hindrances to profitable

ruminant production. Among gastrointestinal nematodiosis, heamonchosis, mecistocirrosis, ostertagiosis, cooperiosis, paracooperiosis, oesophagostomosis, bunostomosis, ascariosis, etc. inflict colossal losses to animal husbandry sector. Infection with gastrointestinal nematode parasites appears to be widespread in the cattle population. Whereas nematode prevalence in cattle is high; their association with outbreaks of clinical disease is lower. This has focused attention on their so-called subclinical effects, particularly reduction of milk production in lactating cows. Constant exposure to low infection apparently can depress milk production. Subclinical effects also have been demonstrated in young animals and include depressed rates of weight gain and interference in energy and nitrogen metabolism.

The major feature of the pathogenesis of all gastrointestinal helminth infections is anorexia of the parasitized animals. The degree of anorexia varies from animal to animal depending upon various factors like worm load, physiological status and environmental stress etc., but there is a profound reduction in overall feed intake. There is as much as 20 per cent reduction in feed intake in moderate to heavy infections although in light infections it may be less obvious (Gibbs, 1982). This contributes to the poor weight gains and lowered production seen in parasitized animals. Further, in addition to the loss of whole blood brought about by the blood sucking activities of the haematophagous nematodes, gastrointestinal parasites cause a protein-losing gastroenteropathy. There is disruption of protein metabolism due to leakage of proteins into intestines and resultant hypoproteinaemia, particularly hypoalbuminaemia. The reduced feed intake & altered protein metabolism causes impairment in proper utilisation of nutrients required for growth and reproduction thus affecting the animal adversely. Anaemia may be seen after prolonged infection with the non-haematophagous nematodes also which is attributed to deficiency of amino acids required for haemoglobin synthesis. Disorders in mineral metabolism are also induced by gastrointestinal parasitism. Reduced calcium, phosphorus and

magnesium absorption, reflected by reduced deposition of these elements in skeletal bones, results in reduced bone growth in young animals (Sykes *et al.*, 1975).

The prevalence of gastrointestinal parasites in livestock depends upon the local climatic conditions and the prevalent managerial practices in that area. Therefore, to devise the control measures of parasitic diseases, the parasitic fauna of each and every species has to be mapped out accurately in different agro-climatic zones of the world. This necessity has been recognised adequately by veterinary parasitologists all over the world and thus extensive surveys have been carried out on parasitic prevalence in different areas of the world. The need to carry out such surveys in Jammu & Kashmir also is thus obvious. The incidence of parasitic infection in dairy cattle from Jammu region has been reported by Raina *et al.*, 1999 and Yadav *et al.*, 2005, and from Kashmir valley also few studies have been carried out (Mir *et al.*, 2003; Pandit *et al.*, 2004 and Bushra *et al.*, 2013). The studies carried out by Mir *et al.*, 2003, Pandit *et al.*, 2004 and Bushra *et al.*, 2013 are restricted to southern and central zone of Kashmir valley (Shopian, Srinagar, Budgam and Ganderbal districts) and no such work has been carried out in north Kashmir (Baramulla, Kupwara and Bandipora districts). Therefore, there is requirement of carrying out studies on epidemiology of gastrointestinal parasites in northern zone of Kashmir valley to generate sufficient data on prevalence and seasonal distribution of gastrointestinal helminth parasites of cattle to evolve a package of practices for timely prophylactic and therapeutic measures to prevent economic losses.

Since chemotherapy and chemoprophylaxis is still the most effective weapon to fight the menace of parasitic diseases, therefore it is very necessary to conserve the efficacy of currently available antiparasitic drugs by their use in a judicious and scientific manner keeping in mind the epidemiology of parasitic

infections in particular geographical regions. With this background information in mind, the present study was undertaken with following objectives:

- 1) To study the prevalence of gastrointestinal helminth parasites affecting the cattle in north Kashmir (Baramulla, Kupwara and Bandipora districts).
- 2) To find out seasonal variation in distribution and severity of different species of helminth parasites.
- 3) To evaluate the therapeutic efficacy of some commonly used anthelmintics against gastrointestinal helminth parasites of the cattle.
- 4) To find out the development of resistance against commonly used anthelmintics, if any.

Chapter – 2

REVIEW OF LITERATURE

2.1 Prevalence studies

Since the occurrence of parasites and parasitic diseases is greatly influenced by varying climatological and ecological factors, therefore the parasitic fauna of different species of livestock in each and every region mapped out accurately forms a fundamental information on which prophylactic and therapeutic measures can be based upon. This necessity has been adequately recognized by parasitologists all over the world and extensive surveys on parasitic fauna of different species of livestock have been carried out not only in different parts of world but also almost in all states of India. The work carried out on epidemiological aspects of cattle parasites during the last two decades is briefly reviewed below:

2.1.1 Work done abroad

Chowdhury *et al.* (1993) examined the rectal faecal samples of Zebu cattle in Dhaka and observed that out of a total of 737 samples examined, 589 (79.9%) samples were positive for helminth infection. Overall prevalence for *Fasciola* spp., paramphistomes, *Schistosoma* spp., strongylids, *Ascaris* spp., *Strongyloides* spp., *Trichuris* spp. and *Capillaria* spp. were, respectively 19.5, 48, 5.9, 52.2, 1.5, 2.5, 5.5, and 12.7 per cent. Prevalence of *Fasciola* spp. and paramphistomes was significantly ($P < 0.01$) higher in animals after one year of age, whereas strongylids, *Ascaris* spp., *Strongyloides* spp. and *Trichuris* spp. infestations were significantly ($P < 0.01$) higher in cattle upto one year of age.

Kanyari *et al.* (1995) on the basis of faecal examination of calves in Kajiado district of Kenya reported that the prevalence of *Toxocara vitulorum* ranged between

6 and 10.7 per cent. Other parasites encountered were strongyles (3.6-36.2%), *Strongyloides* spp. (1.8-4.3%), *Trichuris* spp. (2.0-4.5%) and tapeworms (2.0-2.8%).

On the basis of monthly collections of abomasa and the cranial portion of small intestine of native Wyoming cattle, the predominant species found were: *Ostertagia ostertagi* (98%), *Cooperia oncophora* (60.6%), *Ostertagia bisonis* (41.8%), *Cooperia bisonis* (33.6%) and *Trichostrongylus axei* (27.9%). One trematode, *Fasciola hepatica* and a cestode, *Moniezia benedeni* were also found. *T. axei*, *T. longispicularis*, *Ostertagia circumcincta* and *Ostertagia lyrata* were found for the first time in cattle in Wyoming (Malczewski *et al.*, 1996).

Waruiru *et al.* (1998) conducted an abattoir survey of gastrointestinal nematode infections in cattle in the central highlands in Kiambu District, Kenya and found prevalence of nematodes to be 86.8 per cent. The order of prevalence was *Haemonchus placei* (67.0%), *Cooperia pectinata* (53.0), *Cooperia punctata* (41.7%), *Oesophagostomum radiatum* (38.4%), *Trichostrongylus axei* (24.3%), *Nematodirus helvetianus* (19.6%), *Trichuris globulosa* (9.7%) and *Strongyloides papillosus* (3.6%).

Holland *et al.* (2000) identified following helminths on the basis of post-mortem examination of tracer calves in the Red River Delta in Vietnam: *Toxocara vitulorum*, *Cooperia punctata*, *Cooperia pectinata*, *C. oncophora*, *Oesophagostomum radiatum*, *Trichostrongylus axei*, *T. colubriformis*, *Haemonchus* spp., *Fasciola* spp. and *Paramphistomum* spp.

Mondal *et al.* (2000) examined the gastrointestinal tract of slaughtered tracer calves in Mymensingh, Bangladesh which had been released for a month into grassland and found six species of nematode and one cestode. The nematode species were *Haemonchus contortus*, *Trichostrongylus axei*, *Mecistocirrus digitatus*, *Oesophagostomum* spp., *Trichuris* spp. and *Bunostomum* spp. The cestode was one of

the genus *Moniezia*. The number of parasites in each cow calf was from 42 to 154 for *Haemonchus contortus*, from 18 to 33 for *Trichostrongylus axei*, from 15 to 34 for *Mecistocirrus digitatus*, from 22 to 47 for *Oesophagostomum* spp., from 23 to 32 for *Trichuris* spp. from 13-32 for *Bunostomum* spp. and from 3 to 16 for *Moniezia* spp.

Belem *et al.* (2001) carried a survey of the parasites of abomasa, small and large intestine of cattle in Burkino Faso, West Africa. *Cooperia* spp. was most prevalent (89.4%) followed by *Haemonchus contortus* (66%) and *Oesophagostomum radiatum* (42.6%).

The prevalence of *Fasciola* spp. was found to be 36 per cent in cattle in areas of Kathmandu valley of Nepal from 23 April 2003 to 30 June 2003. Other parasites were also found which included *Paramphistomum* spp. (48%) (Adhikari *et al.*, 2003).

Keyyu *et al.* (2005) conducted a longitudinal study to determine the prevalence, distribution and intensity of gastrointestinal nematodes in traditional, small scale dairy and large scale dairy farms in Iringa district, Southern highland of Tanzania. The predominant nematodes were *Cooperia* spp. (51.6%), *Oesophagostomum radiatum* (35.7%) and *Haemonchus placei* (10.2%).

Fikru *et al.* (2006) on the basis of coprological examination of cattle in Western Oromia, Ethiopia found an overall prevalence of gastrointestinal parasites to be 50.2 per cent. Strongyles were most prevalent parasites encountered.

On the basis of coprological examination, Kaewthamasorn and Wongsamee (2006) found that the overall prevalence of gastrointestinal parasites in beef cattle was 61 per cent in the tropical livestock farming system in Nan Province, northern Thailand. The most common helminth infections were rumen flukes (28%) followed by strongyles (27%), *Strongyloides* spp. (1%) and *Trichuris* spp. (1%).

Moyo (2006) on the basis of examination of gastrointestinal tracts of cattle in Midlands Province, Zimbabwe found the most prevalent species of gastrointestinal nematodes to be *Trichostrongylus axei* (100%), *Haemonchus placei* (100%) and *Cooperia pectinata* (100%).

Coprological examination of cattle in Bangladesh by Sardar *et al.* (2006) revealed maximum rate of infection of gastrointestinal parasites in crossbred cattle as compared to native cattle, with the exception of strongylids. Highest infection was observed in rainy season. The infection rates of *Fasciola* spp., *Paramphistomum* spp., *Trichuris* spp. and *Schistosoma* spp. were highest in age group >36 months and *Ascaris* spp., strongylids, *Strongyloides* spp. and *Moniezia* spp. were very high in the age group <12 months.

Wymann *et al.* (2007) on the basis of post mortem examination of calves in periurban livestock population in Mali found that the most frequent parasite species were *Haemonchus placei* (age group 0-1months: 7%, 1-4 months: 38%, 4-13 months: 69%), *Cooperia pectinata* (0, 33 and 44%) and *C.punctata* (0, 33 and 38%).

The prevalence of gastrointestinal parasites was determined in a dairy & beef farm in Costa Rica by Jimenez *et al.* (2007). The most prevalent helminth parasites detected on both farms were strongyles (75.0 & 81.4%) and *Strongyloides papillosus* (29.8 and 31.7%). Other gastrointestinal parasites found were *Moniezia benedeni* (4.8 and 9.1%), *Trichuris* spp. (7.3 & 13.2%) and *Toxocara vitulorum* (0.0 & 1.8%).

Pfukenyi *et al.* (2007) on the basis of coprological examination of cattle in Zimbabwe found an overall prevalence of gastrointestinal nematodes to be 43.00 per cent and cestodes 4.8 per cent. The most prevalent genera of gastrointestinal nematodes were *Cooperia* spp., *Haemonchus* spp., *Trichostrongylus* spp. and *Oesophagostomum* spp. *Haemonchus* spp. was significantly more prevalent during the wet season than the dry season. In contrast, *Trichostrongylus* spp. was present in

significantly higher numbers during the dry months than wet months, while *Cooperia* spp. and *Oesophagostomum* spp. revealed no significant differences between wet and dry seasons.

Raza *et al.* (2009) carried the examination of rumen of slaughtered cattle in district Muzaffar Garh in Pakistan and found the prevalence of adult *Paramphistomum cervi* to be 17.64 per cent.

Adama *et al.* (2009) studied the prevalence of gastrointestinal helminths from faecal samples of cattle at the Federal University of Technology Farm Minna, Nigeria. The overall prevalence of gastrointestinal helminths in calves, yearlings and adult cattle were 45, 33.3 and 23.3 per cent, respectively. *Haemonchus* spp. and Ascarids had the highest level of prevalence in calves with 25 per cent each. In yearlings, Ascarids and *Fasciola* spp. were high with 30 and 20 per cent respectively while in adults *Haemonchus* spp. was found to have the highest percentage prevalence rate of 35.7 per cent.

An overall prevalence of gastrointestinal parasites in calves in Toba Tek Singh area of Punjab in Pakistan was found to be 56.25 per cent by Bilal *et al.* (2009). Calves between 1-6 months of age exhibited highest prevalence (69.05%) compared to age group of 7 to 12 months (42.10%). Calves on grazing were heavily infected (75%) than those of stall-fed (46.16%). Male calves were more affected (88.38%) than female calves (59.46%).

On the basis of faecal examination of cattle in the University of Maiduguri research farm, Nigeria, prevalence rate of gastrointestinal parasites was reported to be 47.0 per cent by Bui *et al.* (2009). The study also revealed younger cattle were more infected (50.0%) compared to the older ones (44.0%).

The prevalence rates of different gastrointestinal parasites in dairy cows, heifers and calves were found to be 72.27 per cent, 75.95 per cent and 83.59 per cent, respectively in Mymensingh district of Bangladesh (Akter *et al.*, 2011).

Degefu *et al.* (2011) carried a crosssectional study to determine the prevalence and intensity of gastrointestinal parasites in small holder dairy cattle farms of Jimma town, Ethiopia. The predominant helminth parasites were *Paramphistomum* spp. (48.6%), strongyles (32.4%), *Fasciola* spp. (23.3%), *Moniezia* spp. (5.2%), *Strongyloides* spp. (3.3%), *Toxocara vitulorum* (2.4%), *Trichuris* spp. (1.9%), *Capillaria* spp. (1.4%) and *Nematodirus* spp. (0.9%). The overall infection rates for nematode, cestode, trematode and mixed infections were 42.3, 5.2, 71.9 and 19.7 per cent, respectively. The overall prevalence of helminth infection was high in October (81.3%) and low in February (52.4%).

Paul *et al.* (2011) on the basis of faecal examination of cattle in Sirajgonj district in Bangladesh found 53.1 percent to be infected with single or multiple species of paramphistomes. Prevalence was found to be higher in older (60.3%) than young (54.0%) and growing (44.4%) animals.

Rajakaruna and Warnakulasooriya (2011) studied the prevalence of gastrointestinal parasites in four locations in Kandy district of Sri Lanka. *Ascaris* spp. was the common parasite found at all four sites. Other species found were *Fasciola* spp. *Schistosoma* spp. and *Isospora* spp. Less number of parasite eggs was recorded from non-grazing and properly dewormed cattle than the grazing and not properly dewormed ones. The egg counts were high following a high rainfall and low when the rainfall was low.

Ephrem *et al.* (2012) carried a cross sectional study in Dessie municipal abattoir in Ethiopia and found prevalence of fasciolosis to be 25.2 per cent.

Prevalences of 63.29, 18.62 and 17.75 per cent were observed in animals of poor body condition, good body condition and medium body condition, respectively.

Aliyara *et al.* (2012) slaughtered and examined the gastrointestinal tract of 96 cattle at the Yola Modern abattoir of Nigeria and found a prevalence of 75 per cent for naturally acquired infections with *Trichostrongylus* spp. (42%), *Cooperia* spp. (31%), *Strongyloides* spp. (24%), *Oesophagostomum* spp. (44%), *Bunostomum* spp. (11%), *Ostertagia* spp. (3%), *Syngamus* spp. (2%) and *Toxoplasma* spp. (4%), respectively. There were no significant differences ($p>0.05$) in prevalence between sexes and age groups. Out of the 72 infected cattle, 59 or 88 per cent had burdens of <500 worms while burdens of 500-1000 and >1000 were encountered in 6 or 8 per cent and 7 or 10 per cent of the cattle, respectively. A significantly ($p<0.05$) greater number of cattle harbored <500 worms. Although, most of the parasites occurred throughout the study period, higher worm counts were generally encountered during the rainy season than in the dry season.

Awraris *et al.* (2012) carried a cross sectional study to determine the prevalence of gastrointestinal nematodes in cattle in and around Gondar town, Northwest Ethiopia. *Ascaris* spp. (57%), were predominant followed by strongyles (56.07%) and *Trichuris* spp. (16.82). A significantly higher prevalence ($P<0.05$) of infection with nematodes was recorded in calves (41.30%) than in young (34.14%) and adult (23.07%) animals. Sex-wise prevalence of nematodes was not significant ($p>0.05$). For both breeds of cattle, there was a significant difference in prevalence ($P<0.05$) of nematode infections with infection rate of 33.04 and 19.6 per cent for local and cross breeds, respectively.

Edosomwan and Shoyemi (2012) carried the faecal examination of slaughtered cattle in Benin municipal abattoir, Nigeria. The result revealed the presence of twelve gastrointestinal helminth parasites, namely; *Trichuris globulosa*,

Capillaria bovis, *Moniezia benedeni*, *Dicrocoelium hospes*, *Toxocara vitulorum*, *Ostertagia ostertagi*, *Trichostrongylus colubriformis*, *Fasciola gigantica*, *Strongyloides papillosus* and *Taenia saginata*.

Prevalence of fasciolosis in slaughter houses, livestock farms, veterinary hospital and on household cattle under different managemental conditions was found to be 22.6, 17.5, 10.82 and 8.76 per cent, respectively in Punjab (Pakistan) by Khan and Maqbool (2012). Overall highest seasonal prevalence was recorded during autumn followed by spring and winter, while the lowest prevalence was recorded during summer. It was also found that older and male cattle had a higher infection rate than youngsters and female cattle.

Kulusic *et al.* (2012) studied the prevalence of gastrointestinal helminths in calves in western Serbia. Out of 600 calves examined, 64.17 per cent animals were found to be infected. *Toxocara vitulorum* (35.00%) was most predominant followed by *Strongyloides papillosus* (34.50%), gastrointestinal strongyles (4.50%) *Moniezia* spp. (3.17%) and *Trichuris discolor* (2.17%).

Mahmuda *et al.* (2012) carried an investigation to determine the prevalence and distribution of gastrointestinal round worms in calves and found an overall prevalence of 61.57 per cent in Sokoto metropolis, Nigeria. In coproculture examination, *Cooperia* spp. showed highest prevalence (28.78%) followed by *Haemonchus* spp. (26.76%) and *Toxocara* spp. (0.50%).

Marta *et al.* (2013) on random examination of rumens and reticula of cattle in Galicia Spain found paramphistomosis to be prevalent in 18.8 per cent cattle with higher prevalence in beef cattle (29.2%) than in dairy cattle (13.9%).

Nnabuife *et al.* (2013) conducted a study to determine the prevalence of helminths in cattle in Kachia Grazing Reserve, Nigeria. The study revealed the presence of *Oesophagostomum radiatum*, *Bunostomum phlebotomum*, *Trichuris*

globulosa, *Cooperia pectinata*, *Toxocara vitulorum*, *Strongyloides papillosus*, *Strongylus langamus*, *Moniezia benedeni*, *Schistosoma bovis*, *Paramphistomum cervi* and *Fasciola gigantica*. *Paramphistomum cervi* was the most prevalent followed by *Oesophagostomum radiatum*. It was found that prevalence was more in adult cattle than the young stock (calves and yearlings).

Raza *et al.* (2013) on the basis of faecal examination of cattle in Jatoi, Punjab, Pakistan reported an overall prevalence of helminths to be 51 per cent. The highest prevalence was recorded for nematodes (21%) followed by trematodes (17%), cestodes (2%) and mixed helminth infections (11%). *Toxocara vitulorum* (15%) was the most prevalent species of helminth followed by *Fasciola hepatica* (9%), *Paramphistomum cervi* (7%), *Oesophagostomum radiatum* (3%), *Bunostomum phlebotomum* (2%), and *Haemonchus placei*, *Moniezia expansa*, *M. benedeni* and *F. gigantica* were found in 1 per cent samples each. The mixed helminth infection (11%) was often composed of 10 species including *Fasciola hepatica*, *F. gigantica*, *Toxocara vitulorum*, *Moniezia expansa*, *Trichostrongylus* spp., *Paramphistomum cervi*, *Haemonchus placei*, *Oesophagostomum radiatum*, *Bunostomum phlebotomum* and *Cooperia* spp.

Shitta (2013) conducted a study to determine the prevalence of helminth parasites affecting cattle slaughtered at the Wukari abattoir, North-Eastern Nigeria and found an overall prevalence of 34.90 per cent. *Paramphistomum* spp. was most prevalent (23.70%) followed by *Oesophagostomum radiatum* (14.30%), *Fasciola gigantica* (8.90%), *Trichuris* spp. (8.00%) and *Moniezia expansa* (6.60%). It was also found that males had a higher prevalence (38.04%) as compared to females (32.10%). The young cattle between the ages of 0-23 months showed higher prevalence (45.30%) than the adults (30.10%).

The prevalence of natural gastrointestinal nematodes in cattle in Rajshahi district (Bangladesh) was found to be 54.75 per cent (rainy seasons-79.81%, autumn-57.70% summer-44.32% and winter seasons-34.74%). The prevalence of *Ascaris* spp., strongyles (*Haemonchus* spp., *Trichostrongylus* spp., *Oesophagostomum* spp. and *Mecistocirrus* spp.), *Bunostomum* spp., *Trichuris* spp. *Strongyloides* spp. and mixed infection were 11.88, 46.58, 4.11, 9.14, 9.14 and 19.18 per cent, respectively. In the age group of 1-6 months the prevalence of *Ascaris* spp. and strongyles were 33.34 and 3.34 per cent, respectively, in the age of 7-12 months, the prevalence of *Ascaris* spp., strongyles, *Trichuris* spp., *Strongyloides* spp. and mixed infection were 15, 25, 5, 5 and 12.5 per cent, respectively, in the age of 1-2 years, the prevalence of strongyles, *Bunostomum* spp., *Trichuris* spp., *Strongyloides* spp. and mixed infection were 35, 4, 7.5, 7 and 13.5 per cent respectively, in the age of 2 years above, the prevalence of strongyles, *Bunostomum* spp., *Trichuris* spp., *Strongyloides* spp. and mixed infection were 20, 1, 3, 4 and 10 per cent, respectively (Sultana *et al.*, 2013).

2.1.2 Work done in India

Incidence of Fasciolosis in Kashmir valley was found to be 85.1 per cent in cattle by Sharma *et al.* (1989). The prevalence rate varied from 66.6 to 100 per cent in different months of the year. *Fasciola gigantica* was the predominant spp. found.

Borthakur and Das (1998) conducted a study in Assam and found that prevalence of nematode infection was significantly higher in calves (both native and cross-bred) than heifers and cows. Strongyle infection was more common in monsoon and post-monsoon seasons. Different genera of strongyles found were *Haemonchus* spp., *Oesophagostomum* spp., *Trichostrongylus* spp., *Cooperia* spp. and *Bunostomum* spp. *Toxocara* spp., *Strongyloides* spp. and *Moniezia* spp. were found only in calves. Although, *Toxocara* spp. and *Strongyloides* spp. could be found throughout the year,

infection of *Moniezia* spp. was found only in winter months. *Fasciola* spp. and paramphistomes were present throughout the year in heifers and cows.

Bharkad *et al.* (1999) on the basis of coprological examination of cow calves in Marathwada reported 36.87 per cent prevalence of gastrointestinal parasites. The prevalence of *Toxocara vitulorum*, *Strongyloides papillosus*, coccidia and strongyles was found to be 7.80, 16.31, 17.02 and 9.22 per cent, respectively. Males showed higher infection as compared to females.

Hirani *et al.* (1999) found 38.86 per cent prevalence of gastrointestinal parasites in cattle & buffalo in Kheda district of Gujarat. The predominant infections were of amphistomes (21.85%), coccidia (7.86%), strongyles (7.53%), *Fasciola* spp. (2.58%), *Trichuris* spp. (0.97%) & *Moniezia* spp. (0.11%).

Jithendran and Bhat (1999) conducted a survey during two spells of 5 years each (1986-1990 and 1993-1997) to study the prevalence of parasitoses in dairy cattle in the Kangra valley, Himachal Pradesh. *Fasciola* spp. was endemic throughout the year. The faecal egg counts (eggs per gram, epg) of flukes i.e. *Fasciola* spp. and amphistomes ranged from 50 to 300 with high loads during the rainy and post-rainy seasons. The overall monthly mean epg of nematodes ranged from 85 to 1720. On coproculture examination of positive samples, *Strongyloides* was found to be most prevalent followed by *Trichostrongylus* spp., *Haemonchus* spp., *Oesophagostomum* spp., *Bunostomum* spp., and *Mecistocirrus* spp. The prevalence of most of the parasites was lower during the second 5-year period.

Sahoo *et al.* (2002) reported prevalence of helminthic infection to be 19.44 & 55.48 per cent in stall-fed & grazing cattle, respectively in Orissa. Amphistomes (40.30%) were predominant followed by strongyles (2.61%), *Fasciola* spp. (2.11%), *Ascaris* spp. (1.40%), *Strongyloides* spp. (1.11%), *Trichuris* spp. (0.9%) and *Moniezia* spp. (0.6%) in grazing cattle. Presence of *Fasciola* spp.,

amphistomes, *Ascaris* spp., *Strongyloides* spp., *Trichuris* spp., strongyles and *Moniezia* spp. were 0.56, 3.89, 3.89, 1.67, 1.67, 5.0, and 5.6 per cent in stall-fed cattle, respectively. Incidence rate were found higher in rainy season (51.8%) followed by winter (50.7%) & summer (47.6%) season.

Palamapalle *et al.* (2003) on the basis of faecal culture in Maharashtra found that cattle harbour seven strongyle species of which *Trichostrongylus* spp., *Haemonchus* spp. & *Bunostomum* spp. were common. Eggs per gram (EPG) of faeces showed an average EPG of 3163±35.

Pandit *et al.* (2004) on basis of faecal sample examination of organized and unorganised cattle farm in Kashmir valley observed the prevalence of helminth parasites to be 72.46 and 75.02 per cent, respectively. The parasites identified were: *Fasciola gigantica*, *Dicrocoelium dendriticum*, *Paramphistomum cervi*, *Gastrothylax crumenifer*, *Cotylophoron cotylophorum*, *Fischoederius* spp., *Gigantocotyle explanatum*, *Moniezia* spp., *Haemonchus* spp., *Ostertagia* spp., *Mecistocirrus* spp., *Nematodirus* spp., *Oesophagostomum* spp., *Bunostomum* spp., *Trichuris* spp. and *Strongyloides* spp. Season-wise helminth infection in organized sector ranged from 59.00 per cent (summer) to 77.16 per cent (winter). However, 72.50 & 70.94 per cent infection rates were noticed during spring & autumn seasons, respectively. Locally reared cattle showed infection rates of 70.87, 78.54, 77.19 & 70.22 per cent in summer, winter, spring & autumn seasons, respectively.

Agrawal *et al.* (2004) reported prevalence of gastrointestinal parasites in cattle in eight districts of Madhya Pradesh. Infection with amphistomes (11.4-50.9%) was highest followed by strongyles (7.8-47.7%), schistosomes (0.6-9.03%) & *Fasciola* spp. (1.8-6.02%).

The prevalence of gastrointestinal parasites among cattle was found to be 18.22 per cent at central dry zone of Karnataka (Muraleedharan., 2005). Strongyle type of nematodes were found to be most predominant.

Yadav *et al.* (2005) on coprological examination of bovines in R.S Pura, Jammu found 59.68 per cent prevalence of helminthic infections, with 60.51 and 56.61 per cent infection rate found in adults and bovine calves, respectively. Amphistomes (26.56%) were predominant followed by strongyles (8.43%). Percentage prevalence of *Fasciola* spp., *Strongyloides* spp., *Ascaris* spp., *Trichuris* spp. and *Moniezia* spp. was 5.15, 4.53, 7.96, 0.93 and 0.62 per cent, respectively. Incidence of infection was found highest during rainy season (66.35%) followed by winter (57.875%) and summer (54.25%), respectively.

The incidence of paramphistomosis was found to be highest in buffaloes (5.42%) followed by cattle (3.71%), sheep (1.79%) and goats (0.85%) in different districts of Punjab and other adjoining states. Highest incidence was found during monsoon and post-monsoon (July-October) with the prevalence rate of 8.06 per cent followed by 2.92 per cent in summer (March to June) and 0.49 per cent in winter (November to December) (Hassan *et al.*, 2005).

Hirani *et al.* (2006) on basis of coprological examination of cows of Gaushalas in and around Anand, Gujarat found gastrointestinal parasitic infestation rate of 45.76 per cent. The predominant parasites found were amphistomes (17.89%), strongyles (14.17%) and coccidia (7.46%).

An overall infestation of gastrointestinal parasites in adult cows of Panjarapols of middle Gujarat was revealed upto 44.18 per cent by Hirani *et al.* (2006). The major helminth parasite infestations were of amphistomes (16.23%) and strongyles (12.11%). Prevalence was highest during summer (51.83%) followed by monsoon (45.22%) and lowest in winter (35.97%).

Mamatha and D'Souza (2006) on coprological examination of cattle in & around Bangalore found highest infection of strongyles (83.6%) followed by *Moniezia* spp. (8.2%), *Fasciola* spp. (2.4%), amphistome (3.4%) & *Trichuris* spp. (0.4%). The overall mean EPG count of strongyles was 432±49.52. Coproculture studies resulted in maximum recovery of *Bunostomum* spp. followed by *Oesophagostomum* spp. and *Haemonchus* spp.

The prevalence of *Moniezia* spp. was found to be 5, 13.75 and 6 per cent in indigenous, cross bred cow calves and buffalo calves, respectively in villages around Guwahati, Assam by Borthakur and Das (2006). Average eggs per gram of faeces was 56 in buffalo calves, 96.9 in crossbred calves and 19.6 in local cow calves, respectively.

Samanta and Santra (2007) found prevalence of gastrointestinal helminths in cattle in hot & humid zone of West Bengal. The overall infection rate was 76.17 per cent & in cross bred cattle the infection rate was 72.55 per cent & in non-descript cattle it was 80.65 per cent. The infection rate was significantly lower (70.34%) in stall-fed animals than the animals which were managed semi-intensively (82.14%). Age wise infection rate was 77.38, 81.43 & 70.45 per cent in animals below 1 year, within 1-3 years & above 3 years of age respectively. Highest infection rate was observed during summer season (88.24%) followed by rainy (83.76%), spring (80.88%) & autumn (72.73%) season.

Prevalence of Schistosomosis in cattle of Pipriya village of Jabalpur district was found to be 13.67 per cent. Adult animals were found to excrete maximum number of schistosome eggs while young and old minimum (Singh and Agarwal., 2007).

Chavhan *et al.* (2008) found prevalence of nematode parasites of cattle in Nagpur to be 32.18 per cent. The prevalence was found to be highest in monsoon

season (63.07%) followed by winter (32.22%) and summer (21.33%). The percentage of animals infected with *Haemonchus* spp., *Toxocara* spp., *Trichuris* spp., *Strongyloides* spp. and mixed infection was found to be 38.01, 27.68, 14.87, 11.98 and 7.43 respectively.

Shirale *et al.* (2008) on the basis of faecal sample examination of cattle in western Vidarbha Region of Maharashtra found an overall prevalence of gastrointestinal helminth parasites to be 66.28 per cent. The incidence of nematodes were higher (58.00%) followed by cestodes (4.57%) and trematodes (3.71%).

Yadav *et al.* (2008) carried epidemiological study on gastrointestinal nematodes in cattle and found the overall prevalence of 17.79 per cent in 13 districts of Uttarakhand. In coproculture examination, *Haemonchus* spp. was most predominant. The other strongyles found were *Trichostrongylus* spp., *Oesophagostomum* spp., *Bunostomum* spp., *Ostertagia* spp. and *Cooperia* spp.

Kaur and Kaur (2008) on coprological examination observed prevalence of gastrointestinal parasites to be 82.35 per cent in cattle of Patiala. Gastrointestinal parasites detected were *Toxocara vitulorum* (78.57%), *Haemonchus* spp. (57.14%) followed by *Oesophagostomum* spp. (42.86) & *Trichuris* spp. (14.29%).

Singh *et al.* (2008) reported prevalence of gastrointestinal parasites among cattle of Faizabad to be 79.95 per cent. Females (82.7%) were more infected than males (53.37%). Maximum incidence was seen in calves less than 6 months of age (82.1%) followed by calves between 7 months & 1 year (79.5%) & animals above 1 year of age (75.7%). Maximum infection found in rainy season (90.87%) followed by winter (83.27%) & summer season (54%). Amphistomes were found to be predominant.

Yadav *et al.* (2010) on the basis of coprological examination of 5,432 cattle in Delhi, observed an overall prevalence of amphistomes in cattle to be 13.03 per

cent. Monthly prevalence of amphistomes indicated peak prevalence (34.00%) in the month of May.

Jyoti *et al.* (2011) on the basis of coprological examination of cow calves (upto 6 months of age) in 4 major agro-climatic zones of Punjab reported 61.40 per cent prevalence of gastrointestinal parasites. The prevalence of *Toxocara vitulorum*, strongyles, *Strongyloides* spp., *Eimeria* spp. and *Moniezia* spp. was 2.71, 23.29, 14.51, 44.18 and 3.67 per cent, respectively. The prevalence of various parasitic infections was found to be highest in rainy season with significant differences ($p \leq 0.01$) as compared to summer and winter seasons. No significant difference ($p \geq 0.05$) was found among two sexes of calves. However, strongyle and *Eimeria* spp. infection showed a positive correlation with age.

Haque *et al.* (2011) on the basis of coprological examination of cattle and buffaloes in western Punjab reported the prevalence of gastrointestinal parasites in adult animals to be 37.97 per cent. Strongyles (18.99%) were the most prevalent parasites found, followed by *Eimeria* spp. (13.42%), *Moniezia expansa* (5.57%), amphistomes (3.80%), *Strongyloides papillosus* (1.01%), *Trichuris* spp. (0.76%) and *Fasciola* spp. (0.51%). In calves the prevalence of *T.vitulorum*, strongyles, *S.papillosus*, *Eimeria* spp. and *M. expansa* was 6.01, 21.89, 20.17, 53.22 and 3.43 per cent, respectively. The overall prevalence was more in calves than adults and *T.vitulorum* was found only from calves of less than six months of age.

Prevalence of strongyles (22.73%) was highest followed by *Fasciola* spp. (6.18%) and *Paramphistomum* spp (4.04%) in cattle of Kashmir valley. The highest percentage (51.69%) of helminthic infection was recorded in summer season and the lowest in winter season (25.98%) (Hafiz *et al.*, 2011).

Wadhwa *et al.* (2011) on the basis of examination of 100 faecal samples of cattle in Bikaner, Rajasthan reported prevalence of strongyle infection to be 12 per

cent. The prevalence in cattle varied from 9.09 to 12.50 in different locations. The EPG count for strongyle species in cattle was reported to be between 200-1000, with an average of 504.00+245.41.

On the basis of coprological examination of dairy animals (cattle and buffalo) of Punjab, prevalence of gastrointestinal parasites in adults and calves was reported to be 32.77 and 71.18 per cent, respectively. Toxocarosis was found only in calves whereas, trematodal infections were recorded only in adults. (Jyoti *et al.*, 2012)

Coprological examination of cattle in Punjab by Singh *et al.* (2012) revealed the overall prevalence of gastrointestinal parasitic infection to be 16.98 per cent. Among the revealed parasites, amphistomes, *Fasciola* spp., strongyles and *Trichuris* spp. were detected from 3.77, 1.88, 10.69 and 1.26 per cent of examined animals, respectively. The prevalence of *Trichuris* spp. was significantly higher ($p < 0.05$) in younger animals (< 6 months of age). The most prevalent parasites found were strongyles.

Sreedevi (2012) on the basis of coprological examination of 780 dairy cattle in and around Tirupati, Andhra Pradesh, observed an overall prevalence of 44.23 per cent of gastro-intestinal parasites. Nine species of gastro-intestinal parasites were identified, of them six species were helminths, namely amphistomes, *Fasciola* spp., strongyles, *Toxocara* spp., *Trichuris* spp. and *Moniezia* spp. Strongyles were found to be most predominant (35.07%) followed by amphistomes (20.0%). Significantly higher ($p < 0.05$) prevalence of gastro-intestinal parasites was observed in rainy season followed by summer and winter seasons and adults (above one year) were more susceptible.

An overall prevalence of paramphistomosis in cattle in Kamrup district of Assam was found to be 69.81 per cent. The prevalence was found to be highest in the age group of 5-8 years (78.17%) and lowest in 9 years and above (48.95%). The male

(74.55%) and local cattle (86.35%) showed higher prevalence than female (67.13%) and cross-bred animals (46.17%). Seasonal examination revealed highest prevalence of paramphistomosis in monsoon (83.84%) and lower in winter season (54.70%). Free grazing cattle were affected more (86.35%) than stall-fed animals (46.17%) (Biswas *et al.*, 2013).

Bushra *et al.* (2013) conducted a study on prevalence of gastrointestinal helminth parasites of locally reared cattle in Central Zone of Kashmir valley and on the basis of faecal examination reported overall prevalence of gastrointestinal helminth parasites to be 78.02 per cent. The eggs of trematodes, cestodes and nematodes were found in 27.29, 4.16 and 76.66 per cent of faecal samples, respectively. The eggs of various helminths found were those of strongyle worms (73.85%), *Fasciola* spp. (16.45%), paramphistomes (13.12%), *Trichuris* spp. (5.41%), *Moniezia* spp. (4.10%), *Strongyloides* spp. (3.85%), *Dicrocoelium* spp. (2.08%) and *Toxocara vitulorum* (1.04%). On coproculture examination, different species of strongyle worms found were *Haemonchus* spp. (33.78%), *Ostertagia* spp. (21.62%), *Trichostrongylus* spp. (14.86%), *Chabertia* spp. (10.81%), *Bunostomum* spp. (8.10%), *Oesophagostomum* spp. (6.75%) and *Cooperia* spp. (4.05%). The overall egg per gram (EPG) of faeces was found to be 242.66±17.61. Parasitic load was found highest in spring followed by winter, summer and autumn. EPG was also found to be significantly higher in young cattle (295.83±24.98) than in adult cattle (217.64±22.82).

Laha *et al.* (2013) on the basis of faecal examination of cattle on organized farms in Meghalaya found 28.25 per cent samples to be positive for gastrointestinal parasitic infections. The eggs of strongyles were found predominant (65.96 %) followed by *Strongyloides* spp. (25.13%), *Trichuris* spp. (13.08%), *Moniezia* spp. (10.47%) and *Nematodirus* spp. (2.61%). The *Nematodirus* spp. was identified as

Nematodirus helvetianus. The eggs per gram of faeces in case of nematode parasites ranged between 50 to 4000.

An overall prevalence of gastrointestinal helminthiasis in large ruminants (cattle and buffalo) in Jammu area of J&K was found to be 51.29 per cent (67.15% in case of cattle and 38.72% in case of buffaloes) by Mir *et al.* (2013). The most prevalent helminth parasites isolated were *Paramphistomum* spp. (20.32%), *Haemonchus* spp. (11.93%), *Trichuris* spp. (5.16%), *Chabertia* spp. (4.83%), *Dicrocoelium* spp. (2.58%), *Moniezia* spp. (2.25%), *Stilesia* spp. (2.25%) and *Fasciola* spp. (1.93%)

2.2 Therapeutic studies

The parasitic induced diseases in all species of livestock represent serious economic concerns in most of the developed and developing countries of the world. Despite the availability of some good and effective antiparasitic drugs for treatment of important parasitic diseases of the livestock, there is pressing need for adoption of alternative control measures including the development of successful antiparasitic vaccines due to problem of development of resistance by parasites to antiparasitic drug and drug residues in meat and milk. Despite these associated problems chemotherapy and chemoprophylaxis is still the most effective weapon to fight the menace of parasitic diseases and the situation will remain so in nearby future. The work carried out on therapeutic aspects of helminth parasites of cattle during the last few decades is briefly reviewed below:

2.2.1 Work done abroad

Syhre *et al.* (1987) found efficacy of morantel sustained release bolus (MSRB) against gastrointestinal nematodes in first season grazing Holstein calves during the summer-autumn grazing seasons of 1982 and 1983 in western Oregon. Mean worm burdens from tracer calves grazed with treated animals in 1982 & 1983

showed overall reductions of 86.4 and 84.3 per cent respectively. Mean faecal worm egg per gram (EPG) counts of treated animals reflected a reduction of 69 per cent in 1982 and 90 per cent in 1983.

Geerts *et al.* (1987) on suspicion of resistance to levamisole in a strain of *Ostertagia ostertagi* in beef cattle farm in Flanders treated a group of six animals with levamisole (5mg/kg, i.m). The reduction in the number of trichostrongylid eggs per gram of faeces varied between 0 and 66.6 per cent, whereas a similar group treated with fenbendazole (7.5 mg/kg, p.o) showed a reduction in worm burdens of 100 per cent. Coproculture showed that the remaining eggs in the first treatment group were all *Ostertagia* spp. The suspected field strain was compared with a reference strain of *O. ostertagi* by means of the *in vitro* larval paralysis test. This test showed LC₉₅ values of 9.12 µg ml⁻¹ and of 99.04 µg ml⁻¹ for the reference and the field strain respectively, indicating a resistance factor for the latter of 10.9.

Borgsteede (1988) compared the efficacy of morantel tartrate against a susceptible laboratory strain and a field strain of *Ostertagia ostertagi* isolated during the use of a morantel-sustained release bolus in Netherlands. Twenty calves were divided into four groups, Groups 1 and 2 were infected with the susceptible and Groups 3 and 4 were infected with the other strain. Calves of groups 2 and 4 were then treated after 28 days with 10 mg kg⁻¹ morantel tartrate and slaughtered on day 34. Faecal egg output of calves of group 2 fell to zero after treatment, while calves of group 4 remained positive, though lower than before. Worm numbers of calves of group 2 were reduced by 98.5 per cent compared with those of group 1. Calves of group 4 showed a 77.4 per cent reduction in worm burden compared with calves of group 3. It was concluded that it is possible to select an *O. ostertagi* strain with morantel resistance by the use of a morantel-sustained release bolus.

Cattle harboring naturally acquired infections of *Ostertagia* spp., *Oesophagostomum* spp., *Cooperia* spp., *Haemonchus* spp., *Nematodirus* spp. and *Trichuris* spp. were treated with doramectin (200 mc/kg body weight) by the subcutaneous route in Germany (Mehlhorn *et al.*, 1993). At 21 days after treatment, the mean faecal egg counts were reduced by 100 per cent.

Shin-Sung *et al.* (1995) found efficacy of closantel @ 5mg/kg in cows naturally infected with *Fasciola hepatica* in Korea. Eggs were not found in their faeces upto 2 weeks post treatment. However, at 3 and 4 weeks post treatment *Fasciola* ova were found in 7.31 per cent of treated cows. Closantel was not effective against paramphistomes. Calves experimentally infected with 300 *F. hepatica* metacercariae were treated at 18 weeks post infection and eggs were not found in faeces upto 4 weeks.

Williams and Broussard (1995) compared the efficacy of levamisole and thiabendazole with fenbendazole, against gastrointestinal nematode infections in cattle of Baton Rouge, USA. and observed the efficacy of fenbendazole to be 100 per cent against all species, including *Cooperia* spp. L4 and immature *D. viviparus*. The overall efficacy of levamisole and thiabendazole was found to be 93.0-100 per cent against *Haemonchus placei* adults, *Cooperia punctata* and *C. spatulata* adult males, *Cooperia* spp. adult females, *Oesophogastomum radiatum*, *B. phlebotomum*, and *D. viviparus* adults. Efficacy of levamisole was slightly better than that of thiabendazole, although group mean differences for *Ostertagia ostertagi* adults, *Cooperia* spp. L4, *B. phlebotomum* adults and *D. viviparus* E5 (early fifth stage) were not significant ($P < 0.05$).

Williams *et al.* (1995) tested efficacy of fenbendazole (FBZ) to reduce the accumulation of *Ostertagia ostertagi* inhibited early fourth-stage larvae (EL4) in two groups of crossbred beef heifers which were 7-9 months of age. The cattle were

allocated to two groups. Group 1 calves served as non treated control and Group 2 calves were treated with FBZ at 5 mg/kg on day 0 and with 6 day courses of FBZ free-choice mineral on days 28 and 56. Each original group after grazing separately for 105 days was re-allocated to subgroups of three cattle which were treated orally with FBZ, oxfenbendazole (OXZ) or left untreated (CONT). The cattle were necropsied on days 120 and 121. Reduction in numbers of EL4 in original controls, treated with FBZ or OXZ were low, being 60.2 and 74.3 per cent respectively. The largest reduction in *O.ostertagi* numbers was in the FBZ-CONT subgroup. Per cent reduction values for *O.ostertagi* adults, developing L4(DL4) and EL4 were 84.6, 96.7 and 99.0 per cent, respectively. Percent reduction values for adults, DL4 and EL4 in the FBZ-FBZ and FBZ-OXF subgroups were 90.7, 61.3, 85.6 per cent and 92.4, 45.5 and 73.0 per cent respectively.

Maqbool *et al.* (1996) found comparative efficacy of fenbendazole, tetramisole and morantel tartarate against ascariasis in buffalo calves in Pakistan. Group I received 5 mg/kg fenbendazole, group II 15 mg/kg tetramisole, group III 10 mg/kg morantel tartarate and group IV served as untreated control. On 18th day post treatment, fenbendazole, tetramisole and morantel tartarate showed efficacy of 90, 72 and 70.60 per cent, respectively against *Toxocara vitulorum*.

Costa *et al.* (1996) found that closantel @ 2.5 mg/kg (s.c) in cattle in Brazil showed faecal egg count reduction of 0, 57.9, 56.9 and 35.1 per cent on days 1,3,5 and 7 post treatment respectively, compared to controls. Closantel was found highly effective (>90%) against adult *Haemonchus contortus*, 75-90 per cent effective against adult and immature *Bunostomum phlebotomum* and only 50-75 per cent effective against *Trichuris discolor*, *Capillaria bovis* and immature *Cooperia punctata*. It was ineffective against immature *H. contortus* and adult *H. similis*, *Trichostrongylus axei*, *Oesophagostomum radiatum* and *Cooperia punctata*.

Eddi *et al.* (1997) carried a study in Argentina to investigate the period of protection of doramectin compared with ivermectin and fenbendazole against field infections of gastrointestinal parasites of cattle. It was found that duration of protection of a single injection of doramectin was longer than ivermectin or fenbendazole treatment. On Day 56, the total number of parasites found in doramectin-treated animals was significantly ($P < 0.05$) lower than parasite burdens found in either ivermectin or fenbendazole treated animals.

Pitt *et al.* (1997) conducted six trials in Europe at two trial sites to evaluate the therapeutic efficacy of eprinomectin in cattle against *Cooperia* spp., *Dictyocaulus viviparus*, *Haemonchus contortus*, *Nematodirus helvetianus*, *Oesophagostomum radiatum*, *Ostertagia ostertagi*, *Trichostrongylus axei* and *Trichostrongylus colubriformis* (immature infections only). In each trial, animals were artificially infected with a number of nematode species and treated with eprinomectin. In three trials, the nematodes were expected to be at the fourth larval stage of development at the time of treatment, and at the adult stage at the time of treatment in the other three trials. When compared with the untreated control groups, efficacy against the adult and immature nematode infections was > 99 per cent for all the nematode species examined.

Seven studies were conducted by Conder *et al.* (1998) in North America to evaluate the therapeutic efficacy of doramectin pour-on formulation at dosage of 500 µg/kg body weight for cattle harboring naturally-acquired infections of gastrointestinal nematodes. Reductions in faecal egg count (FEC) for the treated animals compared to saline-treated cattle were > or = 96.0 per cent by Day -7 and >or = 99.0 per cent on Days 14 and 21 for each study. Across all studies regardless of weather conditions, the reduction by Day 21 for the treated animals compared to saline controls was 99.7 per cent and compared to pre treatment levels in treated cattle was 99.9 per cent.

Munyua *et al.* (1998) found efficacy of ivermectin sustained-release (IVM SR) bolus designed to deliver 12 mg of the ivermectin/day for 135 days against gastrointestinal nematodes in field grazing calves of Nyandarua district in Kenya. The faecal egg-counts, herbage larval counts and worm burdens of the major gastrointestinal nematodes were significantly reduced.

The persistent anthelmintic efficacy of topical formulations (all at a dosage of 500 µg/kg) of doramectin (DOR), ivermectin (IVM), eprinomectin (EPR) and moxidectin (MOX), in comparison with untreated control cattle (CONT) was tested by Williams *et al.* (1999) in USA. As based on fecal egg counts, anthelmintic activity of EPR and MOX was greater ($p < 0.05$) than for IVM or CONT through Day 28. Activity of DOR was greater ($p < 0.05$) than that of IVM on Days 7 and 14 only. Although significance levels varied little among treated groups from Day 42 to the end of the study, egg counts and percent reduction values of EPR and MOX remained consistently lower than egg counts and higher than reduction values respectively, of DOR and IVM through Day 70. From Day 70 on, IVM counts were not significantly higher than values of CONT.

Gennari *et al.* (2000) conducted a study to evaluate the effect of 2 injections of doramectin or ivermectin in 2 groups of cattle in Brazil. It was found that on day 0, doramectin and ivermectin treated cattle had similar faecal e.p.g counts (840 and 823 e.p.g respectively). On day 30-120, the geometric mean faecal egg counts of the doramectin-treated cattle (25 and 21 e.p.g respectively) were significantly ($P < 0.05$) lower than those of ivermectin-treated cattle (89 and 180 e.p.g respectively). Coproculture examinations showed a high level of prevalence of *Cooperia* spp. and *Haemonchus* spp. throughout.

Doramectin had at the moderate infection level a persistent efficacy of at least 35 days against *O. ostertagi* and at least 28 days against *C. oncophora*; at the

high infection dose persistent efficacy was somewhat shorter i.e. upto 33 days and approximately 28 days, respectively in cattle in Belgium. The duration of persistent efficacy of ivermectin against *O.ostertagi* at the moderate infection level was between 14 and 25 days, at the high dose level upto 25 days (Vercruysse *et al.*, 2000).

Ibara-Velarde *et al.* (2001) found efficacy of combined chemotherapy against gastrointestinal nematodes and *Fasciola hepatica* in cattle in Mexico. Group I served as non-treated control; group II was treated with netobimin orally at 20 mg/kg; group III received triclabendazole orally at 12 mg/kg and levamisole was applied intramuscularly at 5.5 mg/kg; group IV received clorsulon administered subcutaneously (s.c.) at 2 mg/kg and ivermectin (s.c.) at 200 µg/kg. Results showed a reduction of gastrointestinal nematode by 87.3, 95.8 and 99.5 per cent, the percentage reduction of immature flukes was 0.0, 72.5 and 67.5 per cent and for adult flukes 91.0, 97.5 and 100 per cent in groups II, III and IV, respectively.

The efficacy of two formulations of triclabendazole and ivermectin in combination against *Fasciola hepatica* and gastrointestinal nematodes was found by Stevenson *et al.* (2002) in cattle throughout Victoria and New South Wales. Both treatments were highly efficacious (>98% efficacy) against *Fasciola hepatica* and there was also no significant difference between treatments in efficacy. Combined formulation (Fasimec®) was significantly more effective against gastrointestinal nematodes than the separately applied ivermectin and triclabendazole treatment. Mean efficacy for the Fasimec® and Ivomec/Fasinex was 97.6 and 94.2 per cent on day +7, 98.9 and 91 per cent on day +14 and 98.5 and 92.6 per cent on day +21 respectively.

Magona and Musisi (2002) found effect of injectable Moxidectin treatment in Tororo district, Uganda. In the first experiment, the prevalence of nematode

infections and mean faecal egg count (FEC) of the treated group remained significantly lower than that of the untreated group from day 7 to 84. In the second experiment, strategic treatments initially led to 100 per cent reduction of faecal egg count in the treated cattle as compared to 82 per cent in the untreated one. Thereafter, mean faecal egg count in the treated cattle remained below 60 for six months, while that in the untreated cattle fluctuated between 63 and 400, depending on the amount of rainfall.

The efficacy of 5-chloro-2-methylthio-6-(1-naphthoxy)-1-H-benzimidazole (experimental fasciolicide) called compound 'alpha' was evaluated with three commercial fasciolicides in cattle in Veracruz, Mexico (Vera-Montenegro *et al.*, 2003). Group 1 received compound alpha at 12mg/kg p.o.; group 2 triclabendazole at 12mg/kg p.o.; group 3 closantel at 3.5mg/kg s.c.; group 4 clorsulon at 2.0mg/kg s.c.; group 5 animals served as untreated controls. The percentage efficacy for groups 1-4 was 98.1, 98.7, 98.2 and 97.9 on day 14 and 98.5, 97.9, 97.7 and 97.9 on day 21, respectively.

Ayaz and Sahin (2003) found efficacy of moxidectin and doramectin were 100 per cent against gastrointestinal nematode infection after one and two weeks of the treatment in cattle from two private farms in Van Turkey.

Costa and Docente (2004) found the efficacy of the drug combination ivermectin 2.25 per cent + abamectin 1.25 per cent in cattle in Brazil. The results showed that the new drug combination was long acting, more effective against nematodes compared with ivermectin 3.15 per cent.

Maritorena-Diez *et al.* (2005) found that 0.5 per cent moxidectin pour-on at a dose of 0.5 mg/kg body weight was associated with a significant reduction in faecal trichostrongyle egg counts in cows in a ranch in Veracruz, Mexico. The efficacy was 100 per cent at 28 days post treatment.

The efficacy of ivermectin @ 200 micrograms/kg body weight (s.c) was 100, 100 and 95.8 per cent on 7th, 21st and 30th day, respectively after first treatment against gastrointestinal nematodes in calves of Bangladesh Agricultural University Mymensingh (Sarkar *et al.*, 2005). On 30th post-treatment day, the drug was repeated and the efficacy was 100 and 100 per cent on 40th and 60th post-treatment day (from day 0).

Elitok *et al.* (2006) evaluated the efficacy of albendazole (ABZ), rafoxanide (RFX), triclabendazole (TRC) and clorusulan (CLS) against *Fasciola hepatica* in naturally infected cattle in Turkey. The results showed a mean reduction of egg counts by 66.70, 68.20, 78.00 and 84.20 percent in cattle treated with ABZ, RFX, TRC and CLS respectively.

Sixteen calves approximately 6 months old were each infected with 500 metacercariae of *Fasciola hepatica* in United Kingdom. Thirty-two days later they were weighed and divided into two groups and on day 35 all calves in one of the groups were injected subcutaneously with an ivermectin/closantel combination. Both groups were sacrificed between days 70 and 72 to enable counting and examination of the flukes recovered from the bile ducts. It was found that treatment with this combination reduced the population of immature flukes in cattle by 42.6 per cent as compared with the controls and as a result of the stunting effect due to the presence of closantel during early development the size of treated flukes was reduced by 43.9 per cent. (Hanna *et al.*, 2006)

Yazwinski *et al.* (2006) found the persistent activity of moxidectin long-acting injection given subcutaneously at the rates of 0.75, 1.0 and 1.5 mg/kg body weight against various nematode species in cattle. Reductions in strongyle EPG counts relative to controls were greater than or equal to 90 per cent for all the dose rates of

moxidectin for a post-treatment period of 42 days (Wisconsin), 84 days (Arkansas) and 140 days (Louisiana).

Mean faecal egg count reductions ranged from 76.7 to 99.0 for moxidectin injection and -0.8 to 83.4 for ivermectin injection in female *Bos Taurus* beef-type calves in USA (Yazwinski *et al.*, 2006). Moxidectin long-acting injection provided efficacious (immediate as well as long-term) egg count suppressions.

Borgsteede *et al.* (2008) carried three studies to test the efficacy of an ivermectin/closantel injection (200µgm/kg ivermectin & 5 mg/kg closantel) in cattle in Netherlands. Two were experimentally induced infections of *Ostertagia ostertagi*, *Cooperia oncophora* and *Fasciola hepatica* in calves, and the third had natural field infections in cattle with several species of gastrointestinal nematodes and *F. hepatica*. In the two experimental studies, the efficacy of the treatment against *F. hepatica* was 99.2 and 94.5 per cent for 9-week-old flukes and 98.4 and 99.5 per cent for 12-week-old flukes. For *O. ostertagi* in both studies efficacy was 100 per cent and against *C. oncophora* efficacy was 92.0 per cent. In the field study, based on the post mortem fluke and nematode worm counts, efficacy against *F. hepatica*, *O. ostertagi*, *C. oncophora*, *C. punctata*, *Nematodirus helvetianus*, *Trichuris* spp. and against larval intestinal nematodes was 98.4, 100, 99.4, 100, 60.8, 100 and 100 per cent, respectively. The results of the faecal examinations 14 days after treatment showed 100 per cent reduction of egg output for *O. ostertagi*, *C. punctata*, *Trichostrongylus* spp. and *Trichuris* spp. and low egg output of *C. oncophora* and *N. helvetianus*.

Garedaghi *et al.* (2011) reported that 5 per cent closantel orally at a dose of 1 ml/10 kg body weight in cows against *Fasciola hepatica*, *Haemonchus* spp. and *Bunostomum phlebotomum* showed an efficacy of 97 per cent in Iran.

Geurden *et al.* (2012) found the efficacy of a pour-on solution containing moxidectin plus triclabendazole (MOX plus TCBZ) at a dose rate of 0.1 ml/kg

against immature and adult stages of the liver fluke in cattle and compared the efficacy with other commercially available preparations i.e. ivermectin (IVM) plus clorsulon injectable at a dose rate of 0.02 ml/kg and ivermectin (IVM) plus closantel pour-on at a dose rate of 0.1 ml/kg in Belgium. The MOX plus TCBZ treated animals had significantly ($P < 0.0001$) lower fluke counts compared to the untreated control animals. Efficacy against 8-week old and adult flukes was > 99.5 per cent. For 6-week old immature fluke, the efficacy was 98.0 per cent and for 4-week old immature fluke the efficacy was 90.9 per cent. The IVM plus closantel pour-on treated animals had significantly lower fluke counts compared to the untreated control animals for adult and 8-week old flukes ($P < 0.0001$), and for 6-week old flukes ($P = 0.002$). The efficacy was 26.8, 68.2, 90.6 and 99.3 per cent against 4-week, 6-week and 8-week old immature flukes, and adult flukes respectively. The IVM plus clorsulon treated animals had significantly lower fluke counts compared to the untreated control animals for adult ($P < 0.0001$) and 8-week old ($P < 0.05$) flukes. The efficacy was 29.7, 43.4, 53.2 and 99.2 per cent against 4-week, 6-week and 8-week old immature flukes, and adult flukes respectively. For treatments at 4, 6 and 8 weeks after infection, the fluke counts were significantly ($P < 0.0001$) lower for the MOX plus TCBZ treatment than for IVM plus closantel or IVM plus clorsulon. The results confirm the high efficacy ($>90\%$) of the MOX plus TCBZ pour-on combination against 4-week old to adult liver fluke in cattle. The IVM plus closantel pour-on combination was effective ($>90\%$) against 8-week old and adult flukes, but had low efficacy against 4- and 6-week old fluke. The IVM plus clorsulon injectable combination was effective ($>90\%$) against adult fluke only.

Arias *et al.* (2013) evaluated the paramphistomicidal activity of four anthelmintics in dairy cattle naturally infected by *Calicophoron (Paramphistomum) daubneyi* in Spain. Seventy Friesian adult cows were treated at drying-off (19 albendazole; 23 netobimin; 13 closantel and 15 oxclozanide), and 21 remained

untreated as controls. The *C. daubneyi* egg-output was not fully suppressed following the administration of any of the parasiticides. The FECR values ranged from 0 to 26 per cent in the cows receiving albendazole or netobimin, with 11–39 per cent of cattle becoming negative after therapy. Better results were achieved with closantel and oxclozanide, with FECR values of 97-99 per cent and CPCR (cattle positive by coprology reduction) percentages of 85-93 per cent.

Eprinomectin at the dose rate of 1 mg/kg bodyweight provided more than 90 per cent efficacy against challenge with *Cooperia oncophora* and *Cooperia surnabada* at 100 days after treatment; against challenge with *Ostertagia ostertagi*, *Ostertagia lyrata*, *Ostertagia leptospicularis*, *Ostertagia circumcincta*, *Ostertagia trifurcata*, *Trichostrongylus axei*, and *Cooperia punctata* at 120 days after treatment; and against challenge with *Haemonchus contortus*, *Bunostomum phlebotomum*, *Oesophagostomum radiatum* and *Dictyocaulus viviparus* at 150 days after treatment in USA (Soll *et al.*, 2013).

Kunkle *et al.* (2013) found the efficacy of eprinomectin in an extended-release injectable formulation (ERI) when exposed to nematode infected pastures for 120 days in USA in seven locations. Each study had 67-68 naturally infected animals for a total of 475 and were approximately 3-12 months of age. The studies were conducted under a randomized block design based on pre-treatment body weights to sequentially form 17 replicates of four animals each within sex in each study. Animals within a replicate were randomly assigned to treatments, one to Eprinomectin ERI vehicle (control) and three to Eprinomectin ERI (5%, w/v eprinomectin). Treatments were administered at 1 ml/50 kg body weight subcutaneously. At all post-treatment sampling, it was found that Eprinomectin ERI-treated cattle had significantly ($P < 0.05$) lower strongylid egg counts than vehicle-treated controls, with $\geq 95\%$ reduction after 120 days of grazing. Over this same period, Eprinomectin ERI-treated cattle gained more weight (43.9 lb/head) than vehicle-treated controls in all studies.

Lopes *et al.* (2013) tested persistent efficacy of doramectin and ivermectin at a dose of 1 ml/50 kg body weight in cattle experimentally infected with gastrointestinal nematodes in Brazil. Doramectin had persistent efficacy against *H. placei* and *C. punctata* for 49 and 35 days, respectively. The persistent efficacy of ivermectin against *H. placei* lasted for 49 days, but this treatment was ineffective against *C. punctata*. Both formulations demonstrated persistent efficacy against *T. axei* for 49 days. The persistent efficacy of doramectin and ivermectin lasted for 49 and 42 days against *O. radiatum*, respectively.

Rehbein *et al.* (2013) conducted a series of six studies in USA to evaluate the therapeutic efficacy of eprinomectin in an extended-release injection (ERI) formulation against induced infections of developing fourth-stage larval or adult gastrointestinal and pulmonary nematodes of cattle. It was found that efficacy of eprinomectin ERI against developing fourth-stage larvae and adults was ≥ 98 per cent ($p < 0.05$) for the following nematodes: *Dictyocaulus viviparus*, *Bunostomum phlebotomum*, *Cooperia curticei*, *C. oncophora*, *C. surnabada*, *C. punctata*, *Haemonchus contortus*, *H. placei*, *Nematodirus helvetianus*, *Oesophagostomum radiatum*, *O. venulosum*, *Ostertagia leptospicularis*, *O. ostertagi*, *O. circumcincta*, *O. pinnata*, *O. trifurcata* (developing fourth-stage larval infections only), *Strongyloides papillosus*, *Trichostrongylus axei*, *T. colubriformis*, and *Trichuris ovis* (adult infections only).

Shokier *et al.* (2013) found the efficacy of five different anthelmintics against *Fasciola* species in naturally infected cattle in Beni-Suef, Egypt. A total of 55 cattle selected randomly, were divided into 5 treated groups and untreated one. On zero day each group was administered one of the five anthelmintics; albendazole, rafoxanid, oxclozanide, oxclozanide and levamisole in combination and triclabendazole. The efficacy of oxclozanide, oxclozanide and levamisole combination and triclabendazole against fascioliasis was found high with 100 per cent reduction in

fecal egg count in the day 14 post-treatment. The albendazole and rafoxanide groups had lower efficacy levels with faecal egg count reductions between 75 and 80.58 per cent, over the period 7-84 days post treatment.

2.2.2 Work done in India

Gill *et al.* (1989) found efficacy of ivermectin at the rate of 200 µg/kg body weight subcutaneously against gastrointestinal nematodes of buffaloes in Punjab, India. Infection of *Neoascaris vitulorum*, *Oesophagostomum* spp., *Bunostomum* spp. and Trichostrongylidae were eliminated within one week of treatment.

In Orissa, Misra *et al.* (1989) reported that Valbazen (albendazole) @ 7.5 mg/kg body weight for calves and @ 5mg/kg body weight for kids was 100 per cent effective against naturally occurring monieziasis under field conditions.

Sanyal and Singh (1995) tested the nematocidal efficacy and production response in crossbred replacement heifers by low level administration of fenbendazole through urea molasses blocks on a dairy farm in Western India. It was revealed that this anthelmintic delivery system could effectively remove already established parasites and prevent reinfection. The treated heifers gained more weight ($P<0.05$) from the second month with a net gain of 60 g per day.

At Anand, Gujarat, Sanyal (1996) conducted a study to evaluate the efficacy of intraruminal administration of triclabendazole at the dose rate of 12.0 mg/kg body weight in experimentally *Fasciola gigantica* infected crossbred cattle and buffaloes on week 2 and 10 post- infection. It was observed that following treatment, no fluke eggs in faeces and no flukes could be recovered from the liver of cattle both on week 2 and 10 post-infection showing 100 per cent efficacy, while in buffaloes the drug was only 8-9 per cent effective.

Agrawal *et al.* (1997) found the efficacy of a new anthelmintic compound 81-470 (methyl (5-(4-(2-Pyridinyl) -1-piperazinyl) carbonyl) -1H-benzimidazole-2 (yl) carbamate) in Lucknow, U.P against natural strongylid nematode infections of bovine and bubaline calves. It was revealed that the compound @ 20 mg/kg body weight as a single dose, was 100 per cent effective, as EPG became zero on faecal examination from day 7 to 28 post- treatment.

Two trials were conducted against natural and experimentally induced parasitic gastroenteritis in crossbred and buffalo calves using in-feed formulation of albendazole to evaluate its therapeutic and prophylactic efficacy. In the first trial albendazole was incorporated in feed pellets to deliver a minimum daily dose of 0.5 mg kg⁻¹ body weight in order to evaluate its prophylactic efficacy. Whereas in the second trial, feed pellets were offered to deliver a total dose of 7.5 mg kg⁻¹ body weight in two equal split doses in order to evaluate its curative efficacy. It was found that when animals were allowed to feed for consecutive 10 days, sustained plasma concentrations of the compound were achieved which could prevent establishment of infection, whereas albendazole metabolites bioavailability following administration of a therapeutic dose could remove established adults (Sanyal, 1998).

Shanker (1999) found comparative efficacy of three anthelmintic drugs against *Toxocara vitulorum* in cow calves. It was revealed that CDRI compound 81/470 was 100 per cent effective at all the dose rates of 15, 20 and 30 mg kg⁻¹ body weight given per os as a single dose. Fenbendazole was also 100 per cent effective @ 7.5 mg kg⁻¹ body weight. Piperazine citrate was found only 80 per cent effective.

Drug trial with piperazine, ivermectin and levamisole against *Toxocara vitulorum* infection in buffalo calves in Hyderabad indicated that the drug levamisole, ivermectin and piperazine were effective in decreasing order in elimination of ascarid worms and their ova from buffalo calves (Rao *et al.*, 2000).

Study conducted in Pantnagar on 60 buffaloes naturally infected with *Fasciola gigantica* and amphistomes revealed that oxyclozanide at 10 mg/kg body weight was 100 per cent and 86.7 per cent effective against patent infection of *Fasciola gigantica* and amphistomes, respectively. Triclabendazole was 80 per cent effective against *Fasciola gigantica* at 25 mg/kg body weight whereas 12.5 mg/kg body weight was only 20 per cent effective. Combination of fenbendazole (12.5 mg/kg) and triclabendazole (12.5 mg/kg) was comparatively superior to triclabendazole alone (12.5 mg/kg) (Pal *et al.*, 2003).

Galdhar *et al.* (2003) studied the efficacy of doramectin @ 1ml/50 kg body weight in buffalo calves of either sex, aged between one to three months, naturally infected with ascariasis in dairy farm of veterinary college Anjora, Durg. It was found that before treatment the mean EPG of calves was 6500 which became zero on 7th day after treatment showing 100 per cent efficacy.

In Nagaland, thirty mithuns of either sex, aged 3.5-4 years with high faecal egg counts were randomly divided into three groups (A, B and C) with ten mithuns in each group. Animals in group A, B and C were treated with ivermectin (0.2 mg/kg. body weight), levamisole (7.5 mg/kg. body weight) and albendazole (15 mg/kg. body weight) respectively. The results showed that ivermectin, levamisole and albendazole caused 100 per cent reduction in the number of ova on 7th, 9th and 12th day after treatment, respectively (Rajkhowa *et al.*, 2003).

Sanyal (2003) studied the efficacy of triclabendazole, incorporated in concentrate feed pellets against induced bovine and bubaline fasciolosis at NDDDB, Anand, India. It was found that the delivery device was efficacious at a dose rate of 12.0 and 24.0 mg/kg body weight for cattle and buffaloes, respectively.

Sahoo *et al.* (2003) in Bhubaneswar observed that the egg per gram count of gastrointestinal nematodes in faeces of cows was reduced to nil by 6th day after

treatment with fenbendazole @ 5 mg/kg body weight orally. An increase of 13.2 per cent in milk yield on 8th day post-treatment was also recorded.

Prasad *et al.* (2004) found that triclabendazole @ 10 mg/kg body weight and tetramisole @ 15 mg/kg body weight given along with supportive drugs to control natural paramphistomosis and gastrointestinal nematodosis in cattle in Ranchi were 100 per cent effective from 10th day post treatment and 7th day post treatment onwards respectively.

Ivermectin control package at the rate of 200 microgram per kg body weight subcutaneously was 100 per cent effective in controlling natural gastrointestinal nematodosis in cattle after 7 days post treatment and up to 20 days in Ranchi (Kumar *et al.*, 2004).

In Ludhiana, Verma *et al.* (2006) carried a study to assess the efficacy of oxcyclozanide and triclabendazole against paramphistomosis in buffaloes. On day 0, the eggs per gram (EPG) of faeces were found to be 770±110.5 (infected and treated group C) and 680±170.5 (infected and treated group D). However, after treatment with oxcyclozanide orally @ 1g 100 kg⁻¹ b.w. and triclabendazole orally @ 10ml/50 kg b.w., it was concluded that oxcyclozanide was much more (100% at day 28 after treatment) efficacious than triclabendazole.

The mean EPG values of ivermectin treated grazing cattle decreased from its 0 day value of 1031.00 ± 38.48 to 445.35 ± 14.30 on 3rd day and became nil on 14th day post treatment against natural infection of different species of nematodes in Assam (Ahmed *et al.*, 2007).

Gadre *et al.* (2008) tested the comparative efficacy of doramectin and fenbendazole against helminth parasites in naturally infected dairy animals of Maharashtra. On the basis of number of days taken for clinico-parasitological cure

and the mean reduction EPG, it was found that doramectin was superior to fenbendazole.

Hafiz and Bhattacharyya (2009) found a comparative efficacy of piperazine, albendazole and ivermectin against natural infection of *Toxocara vitulorum* based on faecal egg count in calves of Assam. Early recovery was found with piperazine than with either albendazole or ivermectin. However, all the three drugs were effective against ascariasis in cattle calves.

In Pantnagar, Yadav *et al.* (2009) evaluated the efficacy of Paraseb BV at different dose rates against naturally acquired infection of *Fasciola gigantica*. In cattle, Paraseb BV @ 25g (B.I.D. × 2 days) was found 100 per cent effective in reducing the eggs per gram of faeces (EPG) on 7, 21 and 28 days post treatment (DPT) while 35g (B.I.D. × 2 days) and 50g (B.I.D. × 1 day) on 14 and 28 DPT, respectively. However, a dose rate of 12.50g (B.I.D. × 2 days) exhibited an efficacy of 94.4 per cent on 7 DPT. Buffaloes treated with Paraseb BV (50g B.I.D. × 2 days) showed cent per cent reduction in EPG on 21 and 28 DPT.

At Mayakole, Krishnagar, Nadia, West Bengal, it was found by Pal (2010) that rafoxanide and oxyclozanide were 100 per cent effective against the mature flukes of *Fasciola gigantica* @ 7.5 and 10 mg/kg b.wt., respectively while triclabendazole was 75.15 per cent effective @ 12 mg/kg b.wt. in buffaloes.

On therapeutic studies, closantel was found to be 100 and 94.44 per cent effective against *Fasciola* spp. and strongyle worms respectively on 14th day post treatment but it was not effective against *Trichuris* spp. Fenbendazole was found to be 100 per cent effective against *Fasciola* spp., amphistomes, *Moniezia* spp., *Trichuris* spp. and strongyle worms on 14th day post treatment. Ivermectin was found to be 100 per cent effective against *Trichuris* spp. and strongyle worms on 14th day

post treatment but was not effective against *Fasciola* spp. and paramphistomes (Bushra, 2010).

In Maharashtra, it was found by Digraskar *et al.* (2012) that a bullock infected with intestinal schistosomosis when treated with praziquantel @ 20 mg/kg body weight orally, responded well to its therapy and showed complete recovery after two treatment regimens at two weeks interval.

Nazir *et al.* (2013) evaluated the efficacy of eprinomectin and ivermectin pour-on in buffalo calves (below 3 months of age) naturally infected with *Toxocara vitulorum*. It was found that a single treatment significantly ($p < 0.05$) reduced egg counts on days 7 and 14 post treatment, with complete elimination on day 21 post treatment. The study also revealed that eprinomectin was a better drug against ascariasis than ivermectin.

A study was carried out in 18 buffaloes of one to eight years of age and naturally infected with strongylosis in village Chak-siyan, R.S.Pura (Jammu) by Nazir *et al.* (2013). It was revealed that eprinomectin pour-on @ 0.5 mg/kg body weight proved to be an excellent drug against strongylosis.

Chapter – 3

MATERIAL AND METHODS

3.1 Location and geography of study area

The study was conducted on locally reared cattle in north Kashmir over a period of one year from July 2013 to June 2014. North Kashmir consists of three districts *viz.*, Baramulla, Kupwara and Bandipora. Baramulla district covering an area of 3,353 sq. km is the largest district in the entire valley. Baramulla district comprises of eight tehsils namely Baramulla, Boniyar, Kreeri, Pattan, Rafiabad, Sopore, Tangmarg and Uri. Baramulla district is bounded by Kupwara in the north, Bandipora in the north-east, Budgam and Poonch in the south and parts of Srinagar and Ladakh in the east. This district is situated at an average height of 5226 ft. above sea level and at 74.3°E longitude and 34.2°N latitude. The climate of district Baramulla is of temperate type with cold snowy winters and pleasant weather in summer. The annual average rainfall is 1270 mm. Kupwara district is situated at an average height of 5,300 ft. above sea level and at 34.5°N and 74.2°E. It occupies an area of approximately 2,379 sq. km. The climate of the district is temperate cum mediterranean type. In the higher reaches the temperature remains cold throughout the year. Average minimum and maximum temperature varies from –5°C to 32°C. The average annual rainfall is 873 mm. Administratively, this district is divided into three tehsils namely Handwara, Karnah and Kupwara. Bandipora is situated at 34.25°N and 74.38°E with an average altitude of 5541 ft. above sea level. The district is surrounded by Himalayan mountains having Kargil district on north, Kupwara in west, Baramulla in south and Ganderbal in east. Average temperature in summer is 23°C and 5°C in winter. The average annual rainfall is 1476.2 mm. The district comprises of three tehsils namely Bandipora, Gurez and Sumbal.

The cattle population of Baramulla district, Kupwara district and Bandipora district is 2.253 lac, 2.561 lac and 1.189 lac, respectively, as per 18th All India livestock census of 2007.

The mean temperature, rainfall and relative humidity of this area during different seasons of the year is shown in the table below.

Table-1: Mean climatological data from summer 2013 to spring 2014

District	Season	Mean temperature (°c)		Mean relative humidity (%)		Total rainfall (mm)
		Max	Min	Morning	Evening	
Baramulla	Summer	20.73	11.50	80.33	78.60	86.63
	Autumn	14.36	5.03	75.33	67	29.80
	Winter	2.50	-6.66	90.33	86.33	96.03
	Spring	8.80	0.50	82.66	80.33	187.13
Kupwara	Summer	29.66	16.76	86.33	58.66	88.43
	Autumn	23.40	6.43	91.33	56.33	22.23
	Winter	9.10	-1.70	93.30	70.33	70.83
	Spring	17.73	5.63	89	67.66	234
Bandipora	Summer	This is a newly created district and meteorological centre in this district has not yet been established.				
	Autumn					
	Winter					
	Spring					

3.2 Study on prevalence

3.2.1 Collection of faecal samples

Studies on the prevalence of gastrointestinal helminth parasites in north Kashmir (Baramulla, Kupwara and Bandipora) were carried out by randomly collecting faecal samples from locally reared cattle of all age groups and of either sex from July 2013 to June 2014. A total of one thousand and one hundred twenty six (1126) samples were collected from all the three districts. Nearly twenty (20) samples were collected from 14 tehsils of above mentioned three districts in each season. The samples were collected directly from the rectum and brought to the laboratory in mini polythene bags for examination. These samples were collected during all the four seasons *viz*; summer (July-August), autumn (September-November), winter (December-February) and spring (March-May), 286 samples in summer, 280 samples each in autumn, winter and spring to study the seasonal prevalence of gastrointestinal helminth infections.

3.2.2 Examination of faecal samples

Before examining the faecal samples microscopically, the gross examination was done by looking for colour, consistency, presence of blood, mucus, tapeworm segments and dead worms which sometimes provided an important clue about the parasitic infection.

The samples were examined qualitatively using sedimentation and floatation techniques for evaluating the incidence of infections.

3.2.2.1 Centrifugal sedimentation techniques

About 3-5 g of faecal sample was triturated in a pestle and mortar with water to prepare a homogenous suspension. The suspension was strained through a sieve to remove the coarse particles and debris. The filtrate was subsequently cleaned several times with water by centrifuging the filtrate at 1000-1500 rpm for 2-3 minutes and decanting the supernatant fluid each time. Few drops of the

sediment were then placed on the slide, covered with a coverslip and examined under the microscope (10x) for presence of eggs of helminths.

3.2.2.2 Centrifugal floatation technique

The centrifuge tube containing the sediment from centrifugal sedimentation technique was filled with saturated salt solution (1.18 specific gravity) to almost half full and again centrifuged for 2-3 minutes at 1000-1500 rpm. After centrifugation the tubes were filled with saturated solution upto the brim till a convex surface was formed at the top. The coverslip was placed directly on the top layer of the solution in the test tube and transferred to a glass slide after 7-15 minutes for examination under the microscope for presence of eggs of nematodes and cestodes.

3.3 Study on parasitic load

A total of 195 randomly selected faecal samples were also examined by quantitative technique (Stoll's dilution method) to determine the parasitic load i.e. eggs per gram of faeces. Samples were examined in each season, 45 samples in summer, 50 in autumn, 55 in winter and 45 in spring season.

3.3.1 Stoll's dilution method

For counting eggs, 3g of faeces were taken into a beaker graduated to 45 ml. The beaker was then filled to the 45 ml mark with decinormal caustic soda solution. Magnetic stirrer was used for shaking to make homogenous suspension of faecal material. The suspension was then sieved and the volume was readjusted to 45 ml using decinormal caustic soda. The suspension was again kept on magnetic stirrer for continuous agitation. While the agitation process was going on, 0.15 ml of this suspension was drawn off using a calibrated pipette and transferred to a glass slide. After covering with a cover glass the total number of eggs in 0.15 ml suspension were counted under low power microscope. The average number of eggs in three aliquots of 0.15 ml was multiplied by 100 to get eggs per gram of faeces.

3.4 Coproculture

A Total of 120 faecal samples (30 samples in each season) positive for strongyle eggs were subjected to coproculture using petridish method and the third stage larvae were harvested to find out prevalence of different genera of strongyle worms.

3.4.1 Petridish method

This technique was used to get maximum number of larvae. A small petridish wrapped with blotting paper was taken and faeces to be cultured was kept in the center of it. This petridish was now placed in another petridish and the space between the two was filled with small quantity of water. The assembly was covered by another large petridish and sample was incubated at 27°C for 7 days. After 7th day of incubation, water was drawn out by a pipette. During this period all the larvae came down into the water and water was taken in centrifuge tubes, centrifuged at 5000 rpm for 10 minutes at 4°C and then sediment was examined. The larvae were identified under light microscope as per the key of Georgi (1985) and Van Wyk *et al.* (2004).

3.5 Therapeutic studies

The therapeutic efficacy of different anthelmintic drugs *viz*; ivermectin, fenbendazole and oxclozanide was determined using the faecal egg count reduction test (FECRT) as per the guidelines of World Association for Advancement of Veterinary Parasitology (WAAVP) for detection of anthelmintic resistance (Coles *et al.* 2006). For this purpose, sixty six cattle suffering from gastrointestinal helminth infection were randomly selected in Rafiabad tehsil of district Baramulla. Among these, the cattle suffering from nematode infection (strongyle positive animals and having EPG above 150) were divided into three groups, each comprising of eighteen animals. First two groups were treated with ivermectin and fenbendazole, respectively and the third group was kept as untreated infected control.

The twelve animals suffering from pure trematode infection (*Fasciola* spp. or Paramphistome positive animals) were divided into two groups. One group comprising of nine animals were treated with oxiclozanide and the other group comprising of three animals were kept as untreated control.

To determine the therapeutic efficacy of different anthelmintic drugs against gastrointestinal helminths, faecal samples from rectum were directly collected on “0” day before treatment and on 8th and 14th day post treatment, in animals positive for nematode infection and on 8th, 14th and 28th day post treatment, in animals positive for trematode infection and EPG (egg per gram) was determined by using Stoll’s method.

The complete schedule of treatment for drug trial, dosage and route of administration is presented in Table-2.

3.5.1 The faecal egg count reduction test (in vivo test)

The efficacy of different anthelmintic drugs was calculated by comparing mean eggs per gram (EPG) on “0” day i.e. before treatment and after treatment on 8th and 14th day (for nematode positive animals) and on 8th, 14th and 28th day (for trematode positive animals) as described by Coles *et al.* (1992) using below mentioned formula:

$$\text{FECR (\%)} = 1 - X_t/X_c \times 100$$

X = Arithmetic mean of EPG 10-14 days post treatment

t = treated group

c = control group

3.6 Statistical Analysis

The results were subjected to standard statistical analysis as per Snedecor and Cochran (1994).

Table 2: Complete schedule of treatment, dosage and route of administration

GI helminth present	Group	Drug used	Dosage	Route of administration
Nematodes	1	Ivermectin	0.2 mg/kg body weight	Subcutaneous
	2	Fenbendazole	7.50 mg/kg body weight	Oral
	3	Control	-	-
Trematodes	1	Oxyclozanide	10 mg/kg body weight	Oral
	2	Control	-	-

Chapter – 4

OBSERVATIONS/FINDINGS

The present study deals with the prevalence and therapeutic studies on gastrointestinal helminth parasites of locally reared cattle in north Kashmir and was carried out over a period of one year from July 2013 to June 2014. Based on objectives the study has been divided into two sections. First section is related with the prevalence of gastrointestinal helminth parasites and the second section deals with the evaluation of the therapeutic efficacy of some commonly used anthelmintics against gastrointestinal helminth parasites of cattle.

4.1 Prevalence of gastrointestinal helminth parasites

This study is based on examination of 1126 faecal samples collected from locally reared cattle of either sex and both the age groups *viz* ; adult cattle (age > 1 year) and young cattle (age < 1 year). Season-wise 286 samples were examined in summer and 280 each in autumn, winter and spring season. The prevalence of gastrointestinal helminth parasites has been studied taking into consideration the overall prevalence, seasonal prevalence, age wise prevalence and sex wise prevalence.

4.1.1 Overall prevalence of gastrointestinal helminths (Table-3, Fig.1)

The qualitative faecal examination revealed that 674 cattle were positive for various gastrointestinal helminth parasites out of 1126 cattle examined with an overall prevalence of 59.86 per cent.

Prevalence of trematodes was found to be 11.63 per cent. Among trematodes, prevalence of paramphistomes (7.10%) was highest followed by *Fasciola* spp. (4.53%) and *Dicrocoelium* spp. (0.27%).

Table-3: Overall age wise prevalence of gastrointestinal helminth parasites of cattle in north Kashmir

Host	No. of samples screened	Number positive for GI helminths	Trematodes				Cestodes			Nematodes			Mixed infection
			F	D	P	Total trematodes	M	Total cestodes	S	St	T	Total nematodes	
Adult	715	394 (55.10 ^a)	42 (5.87 ^b)	2 (0.28)	64 (8.95 ^b)	105 (14.69 ^b)	24 (3.36 ^a)	24 (3.36 ^a)	320 (44.76 ^a)	10 (1.40 ^a)	15 (2.10 ^a)	335 (46.85 ^a)	82 (11.47)
Young	411	280 (68.13 ^b)	9 (2.19 ^a)	1 (0.24)	16 (3.89 ^a)	26 (6.33 ^a)	26 (6.33 ^b)	26 (6.33 ^b)	242 (58.88 ^b)	13 (3.16 ^b)	26 (6.33 ^b)	262 (63.75 ^b)	52 (12.65)
Total	1126	674 (59.86)	51 (4.53)	3 (0.27)	80 (7.10)	131 (11.63)	50 (4.44)	50 (4.44)	562 (49.91)	23 (2.04)	41 (3.64)	597 (53.02)	134 (11.90)

Figures within parenthesis indicate percentage

Values with different superscript in a column under a subgroup vary significantly (P<0.05)

F = *Fasciola* spp., D = *Dicrocoelium* spp., P = Paramphistomes, M = *Moniezia* spp., S = strongyle worms, St = *Strongyloides* spp., T = *Trichuris* spp

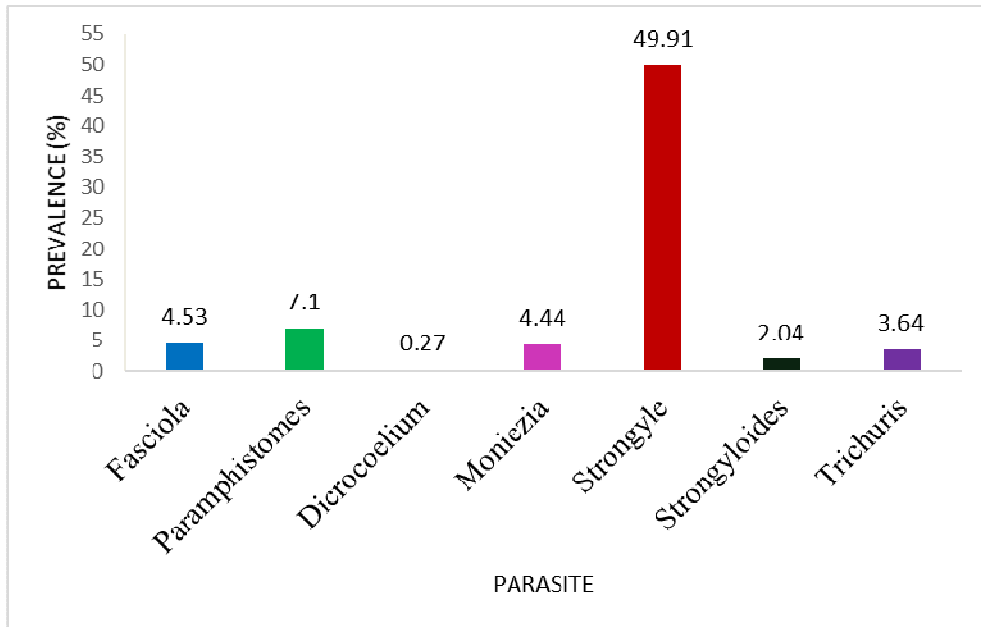


Fig. 1: Overall prevalence of gastrointestinal helminth parasites of cattle in north Kashmir

Among cestodes the only genus reported was *Moniezia* spp. with a percentage prevalence of 4.44 per cent.

Nematodes were found in 53.02 per cent animals. Among nematodes, maximum prevalence was of strongyle worms (49.91%) followed by *Trichuris* spp. (3.64%) and *Strongyloides* spp. (2.04%).

Overall prevalence of mixed gastrointestinal helminth parasites was found to be 11.90 per cent.

4.1.2 Overall Seasonal prevalence of gastrointestinal helminths (Table-4, Fig.2&3)

The data compiled on seasonal basis showed a higher prevalence of gastrointestinal helminth parasites in spring (68.21%) followed by autumn, summer and winter in which prevalence rate was 67.50, 55.59 and 48.21 per cent, respectively. The variation was statistically significant ($P<0.05$) between summer and autumn, summer and spring, autumn and winter, spring and winter.

Higher trematode infection rate of 13.93 per cent was found each in autumn and spring followed by 11.07 and 7.69 per cent in winter and summer, respectively, the variation being significant ($P<0.05$) between summer and autumn, summer and spring. Among trematodes, paramphistomes revealed highest prevalence rate in autumn and spring (9.29% in each season) followed by summer (5.59%) and winter (4.29%), the variation being significant ($P<0.05$) between summer and autumn, summer and spring, autumn and winter, spring and winter. *Fasciola* spp. showed a different seasonal activity with a higher prevalence of 6.43 per cent in winter followed by 5.36, 4.64 and 1.75 per cent in spring, autumn and summer respectively, the variation being statistically significant ($P<0.05$) among summer and autumn, summer and winter, summer and spring. Highest prevalence of *Dicrocoelium* spp. was found in winter (0.71%) followed by summer (0.35%). *Dicrocoelium* spp. was

Table-4: Seasonal prevalence of gastrointestinal helminth parasites of cattle in north Kashmir

Season	Host	No. of samples examined	Number positive for GI helminth	Trematodes			Cestodes			Nematodes			Mixed infection	
				F	D	P	Total trematodes	M	Total cestodes	S	St	T		Total nematodes
Summer	Adult	154	86	3	0	12	15	6	6	78	3	4	82	20
	Young	132	73	2	1	4	7	5	5	66	4	6	71	15
	Total	286	159 (55.59 ^a)	5 (1.75 ^a)	1 (0.35)	16 (5.59 ^a)	22 (7.69 ^a)	11 (3.85)	11 (3.85)	144 (50.35 ^b)	7 (2.45 ^{ab})	10 (3.50 ^{ab})	153 (53.50 ^b)	35 (12.24 ^b)
Autumn	Adult	178	120	11	0	19	30	12	12	97	4	8	104	31
	Young	102	69	2	0	7	9	5	5	62	1	7	63	14
	Total	280	189 (67.50 ^b)	13 (4.64 ^b)	0 (0.00)	26 (9.29 ^b)	39 (13.93 ^b)	17 (6.07)	17 (6.07)	159 (56.79 ^b)	5 (1.79 ^{ab})	15 (5.36 ^b)	167 (59.64 ^b)	45 (16.07 ^b)
Winter	Adult	202	83	15	2	11	27	1	1	63	0	1	63	9
	Young	78	52	3	0	1	4	7	7	41	2	3	46	5
	Total	280	135 (48.21 ^a)	18 (6.43 ^b)	2 (0.71)	12 (4.29 ^a)	31 (11.07 ^{ab})	8 (2.86)	8 (2.86)	104 (37.14 ^a)	2 (0.71 ^a)	4 (1.43 ^a)	109 (38.93 ^a)	14 (5.00 ^a)
Spring	Adult	181	105	13	0	22	33	5	5	82	3	2	86	22
	Young	99	86	2	0	4	6	9	9	73	6	10	82	18
	Total	280	191 (68.21 ^b)	15 (5.36 ^b)	0 (0.00)	26 (9.29 ^b)	39 (13.93 ^b)	14 (5.00)	14 (5.00)	155 (55.36 ^b)	9 (3.21 ^b)	12 (4.29 ^b)	168 (60.00 ^b)	40 (14.29 ^b)

Figures within parenthesis indicate percentage

Values with different superscript in a column under a subgroup vary significantly (P<0.05)

F = *Fasciola* spp., D = *Dicrocoelium* spp., P = Paramphistomes, M = *Moniezia* spp., S = strongyle worms, *Strongyloides* spp., T = *Trichuris* spp.

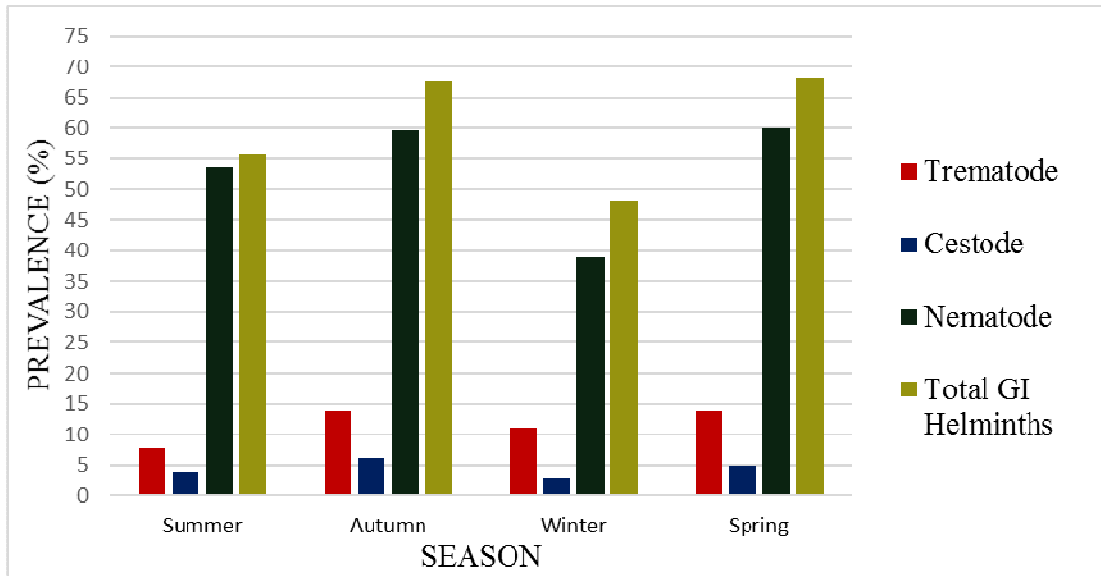


Fig. 2: Comparative seasonal prevalence of trematode, cestode & nematode parasites of cattle in north Kashmir

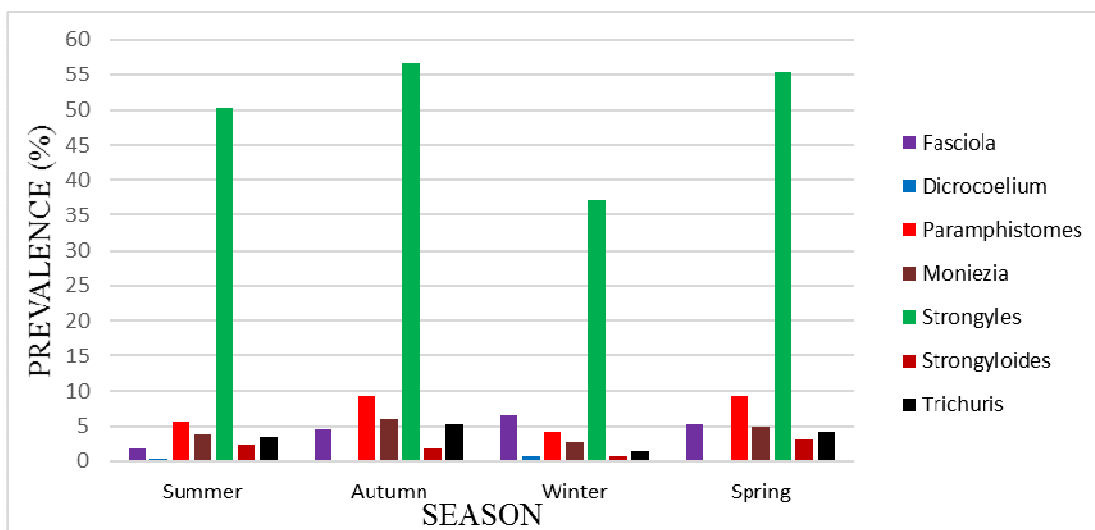


Fig. 3: Comparative seasonal prevalence of gastrointestinal helminth parasites of cattle in north Kashmir

not found in autumn and spring season. The variation was statistically non-significant ($P>0.05$).

Moniezia spp. showed a highest infection rate of 6.07 per cent in autumn and lowest in winter (2.86%). A prevalence rate of 5.00 and 3.85 per cent was observed in spring and summer season respectively. The variation was statistically non-significant ($P>0.05$).

The prevalence of nematodes was found highest in spring (60.00%) followed by autumn (59.64%), summer (53.50%) and winter (38.93%). The variation was statistically significant ($P<0.05$) between winter and summer, winter and autumn, winter and spring. The prevalence of strongyle worms was highest in autumn (56.79%) followed by spring (55.36%), summer (50.35%) and winter (37.14%), the variation being statistically significant ($P<0.05$) between winter and summer, winter and autumn, winter and spring. *Trichuris* spp. followed a similar pattern revealing higher prevalence rate in autumn (5.36%), followed by spring (4.29%), summer (3.50%) and winter (1.43%), the variation being statistically significant ($P<0.05$) between autumn and winter, winter and spring. Highest prevalence of *Strongyloides* spp. was found in spring (3.21%) followed by summer (2.45%), autumn (1.79%) and winter (0.71%). The variation was statistically significant ($P<0.05$) between winter and spring.

Mixed infection was found more in autumn (16.07%) followed by spring (14.29%), summer (12.24%) and winter (5.00%). The variation was statistically significant ($P<0.05$) between summer and winter, autumn and winter, spring and winter.

4.1.3 Overall Age-wise prevalence of gastrointestinal helminths (Table-3, Fig.4)

Out of 1126 samples, 715 samples were collected from adults and 411 were collected from young cattle. In case of adults, out of 715 samples examined, 39

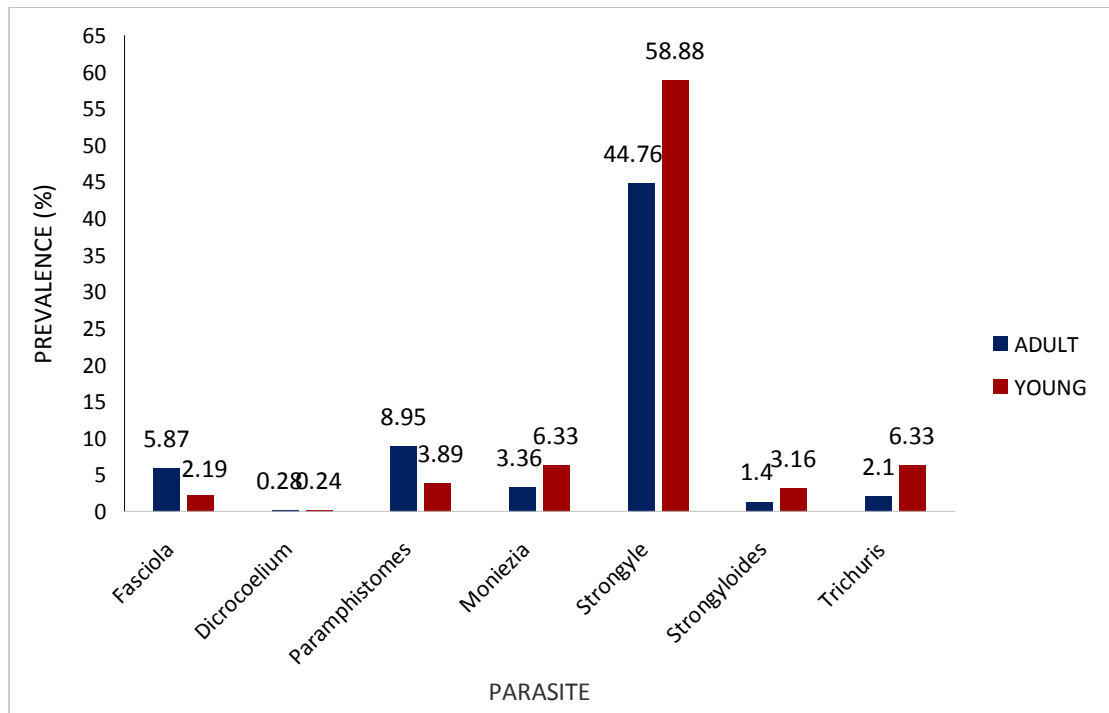


Fig. 4: Age wise prevalence of gastro-intestinal helminth parasites of cattle in north Kashmir

samples were found positive and in young cattle, out of 411 samples examined 280 were found positive for gastrointestinal helminth parasites. Overall prevalence of gastrointestinal helminth parasites was found more in young cattle (68.13%) compared to adults in which prevalence rate was 55.10 per cent. The study revealed statistically significant difference between the two age groups ($P < 0.05$).

The prevalence of trematodes was found significantly ($P < 0.05$) higher in adults (14.69%) as compared to young cattle (6.33%). *Fasciola* spp. (5.87%) and paramphistomes (8.95%) were also found higher in adults as compared to young cattle in which prevalence rates were 2.19 and 3.89 per cent respectively, the variation being statistically significant. ($P < 0.05$). *Dicrocoelium* spp. was also found higher in adult cattle (0.28%) as compared to young (0.24%), the difference being statistically non-significant ($P > 0.05$).

Moniezia spp. showed a higher prevalence in young cattle (6.33%) compared to 3.36 per cent in adult cattle. The difference was statistically significant ($P < 0.05$).

Nematodes were found higher in young cattle (63.75%) in comparison to adults (46.85%), the variation being statistically significant ($P < 0.05$). Strongyle worms were also found significantly ($P < 0.05$) higher in young cattle (58.88%) compared to adults (44.76%). *Strongyloides* spp. and *Trichuris* spp. followed similar trend with higher prevalence in young cattle (3.16 and 6.33%) as compared to adults (1.40 and 2.10 %), the variation being statistically significant ($P < 0.05$).

Mixed infection was found higher in young (12.65%) compared to 11.47 per cent in adult cattle, the difference being statistically non-significant ($P > 0.05$).

4.1.4 Overall Sex wise prevalence of gastrointestinal helminths (Table-5, Fig.5)

Out of 1126 samples, 340 samples were collected from male and 786 were collected from female. In case of males out of 340 samples examined, 198 samples.

Table-5: Sex-wise prevalence of gastrointestinal helminth parasites of cattle in north Kashmir

Sex (Host)	No. of samples screened	Number positive for GI helminths	Trematodes			Total trematodes	Cestodes		S	Nematodes			Mixed infection
			F	D	P		M	Total cestodes		St	T	Total nematodes	
Male	340	198 (58.24)	14 (4.12)	1 (0.29)	16 (4.71 ^a)	30 (8.82)	11 (3.24)	11 (3.24)	181 (53.24)	7 (2.06)	13 (3.82)	186 (54.71)	43 (12.65)
Female	786	476 (60.56)	37 (4.71)	2 (0.25)	64 (8.14 ^b)	101 (12.85)	39 (4.96)	39 (4.96)	381 (48.47)	16 (2.04)	28 (3.56)	411 (52.29)	91 (11.58)
Total	1126	674 (59.86)	51 (4.53)	3 (0.27)	80 (7.10)	131 (11.63)	50 (4.44)	50 (4.44)	562 (49.91)	23 (2.04)	41 (3.64)	597 (53.02)	134 (11.90)

Figures within parenthesis indicate percentage

Values with different superscript in a column under a subgroup vary significantly (P<0.05)

F = *Fasciola* spp., D = *Dicrocoelium* spp., Paramphistomes, M = *Moniezia* spp., S = strongyle worms, St = *Strongyloides* spp., T = *Trichuris* spp.

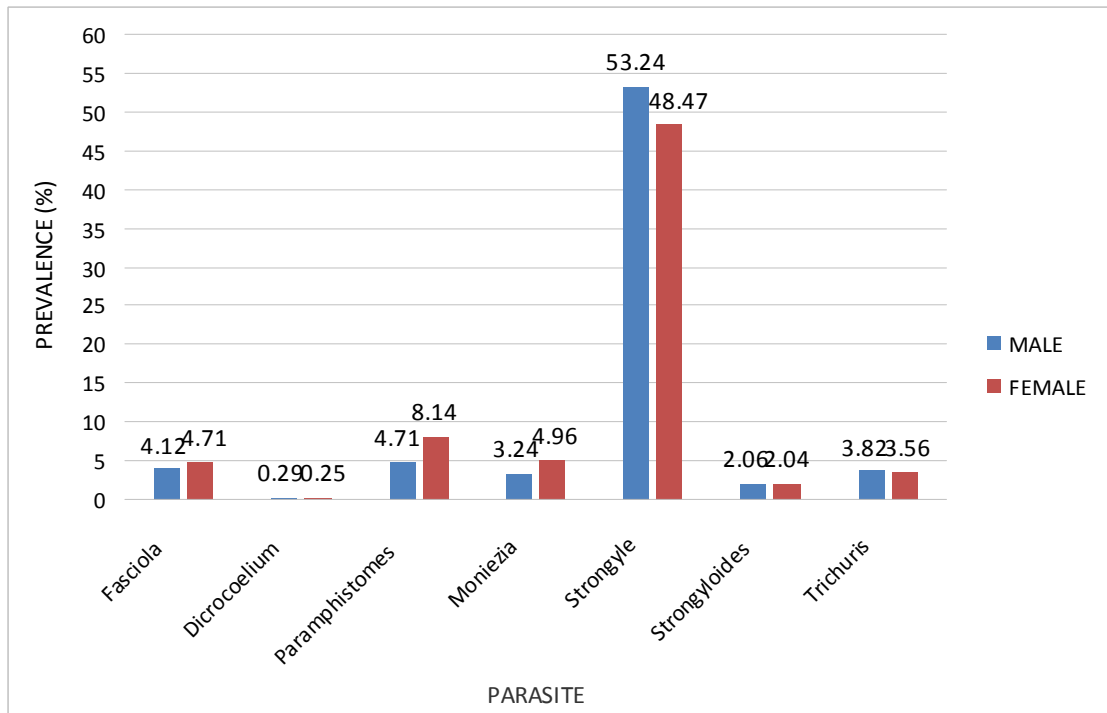


Fig. 5: Sex wise prevalence of gastro-intestinal helminth parasites of cattle in north Kashmir

(58.24%) were found positive and in females, out of 786 samples examined, 476 (60.56%) were found positive for gastrointestinal helminth parasites. Gastrointestinal helminth parasites were found non-significantly ($P>0.05$) higher in females compared to males.

The prevalence of trematodes was found non-significantly ($P>0.05$) higher in females (12.85%) compared to males (8.82%). *Fasciola* spp. and paramphistomes were found higher in females with prevalence rate of 4.71 and 8.14 per cent compared to males in which prevalence rates were 4.12 and 4.71 per cent respectively, the variation being statistically non-significant ($P>0.05$) for *Fasciola* spp. and significant ($P<0.05$) for paramphistomes. *Dicrocoelium* spp. showed a different activity with a higher prevalence rate of 0.29 per cent in males compared to females (0.25%), the variation being statistically non-significant ($P>0.05$).

Moniezia spp. showed a higher prevalence in females (4.96%) as compared to males (3.24%), the variation being statistically non-significant ($P>0.05$).

Nematodes were found non-significantly ($P>0.05$) more in males (54.71%) in comparison to 52.29 per cent in females. Strongyle worms followed a similar pattern with non-significantly ($P>0.05$) higher prevalence in males (53.24%) compared to 48.47 per cent in females. *Strongyloides* spp. and *Trichuris* spp. also followed similar trend with higher prevalence in males in which prevalence rates were 2.06 and 3.82 per cent compared to females in which prevalence rates were 2.04 and 3.56 per cent respectively, but the variation was statistically non-significant ($P>0.05$).

Mixed infection was found higher in males (12.65%) compared to 11.58 per cent in females, the variation being statistically non-significant ($P>0.05$).

4.2 Parasitic load (Table-6, 7 & 8, Fig. 6, 7 & 8)

Randomly selected 15-20 per cent faecal samples were examined in each season by quantitative technique (Stoll's dilution method) to determine the parasitic load i.e.



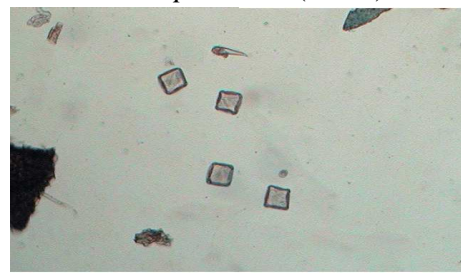
Fasciola spp. (100X)



Paramphistome (100X)



Dicrocoelium spp. (400X)



Moniezia spp. (100X)



Strongyle worms (100X)



Trichuris spp. (400X)



Nematodirus spp. (100X)



Strongyloides spp. (100X)

Plate-1 : Faecal examination revealing eggs of *Fasciola* spp., *Paramphistome*, *Dicrocoelium* spp., *Moniezia* spp., Strongyle worms, *Trichuris* spp., *Nematodirus* spp., and *Strongyloides* spp.

eggs per gram (EPG) of faeces.

Total 195 samples were examined to determine the parasitic load. Eggs per gram of faeces ranged from 0-400 and an average EPG was found to be 177.44 ± 6.29 .

In summer season, 45 samples out of 286 samples were examined for parasitic load and eggs per gram of faeces ranged from 0-300 with an average EPG of 211.11 ± 11.56 . In autumn season 50 samples out of 280 samples were examined and eggs per gram of faeces ranged from 0-300 with an average EPG of 148.00 ± 11.15 . In winter season 55 samples out of 280 samples were examined and eggs per gram of faeces ranged from 0 to 200 with an average EPG of 132.73 ± 8.32 . In spring season 45 samples out of 280 samples were examined and eggs per gram of faeces ranged from 0-400 with an average EPG of 231.11 ± 14.15 . Average EPG was found highest in spring followed by summer, autumn and winter. The variation was statistically significant ($P < 0.05$) between summer and autumn, summer and winter, autumn and spring, winter and spring.

Out of total 195 faecal samples examined for EPG, 70 samples were of young cattle and eggs per gram of faeces ranged from 0-400 with an average EPG of 195.71 ± 9.85 and 125 samples were of adults and eggs per gram of faeces ranged from 0-400 with an average EPG of 167.20 ± 89.60 . Average EPG was found higher in young cattle as compared to adults. The variation was statistically significant ($P < 0.05$).

128 samples were of females out of total 195 faecal samples examined for EPG and eggs per gram of faeces ranged from 0-400 with an average EPG of 189.84 ± 7.91 and 67 samples were of males and eggs per gram of faeces ranged from 0-400 with an average EPG of 153.73 ± 9.82 . Average EPG was found higher in females as compared to males, the variation being statistically significant ($P < 0.05$).

Table-6: Seasonal comparison of parasitic load of gastrointestinal helminth parasites of cattle in north Kashmir

Season	Host	No. of samples screened	EPG range	Mean EPG
Summer	Adult	30	0-300	193.33±14.33
	Young	15	100-300	246.67±16.52
	Total	45	0-300	211.11±11.56^b
Autumn	Adult	30	0-300	136.67±14.77
	Young	20	0-300	165.00±16.66
	Total	50	0-300	148.00±11.15^a
Winter	Adult	33	0-200	121.21±11.31
	Young	22	100-200	150.00±10.91
	Total	55	0-200	132.73±8.32^a
Spring	Adult	32	0-400	218.75±17.06
	Young	13	100-400	261.54±24.12
	Total	45	0-400	231.11±14.15^b

Values with different superscript in a column under a subgroup vary significantly (P<0.05)

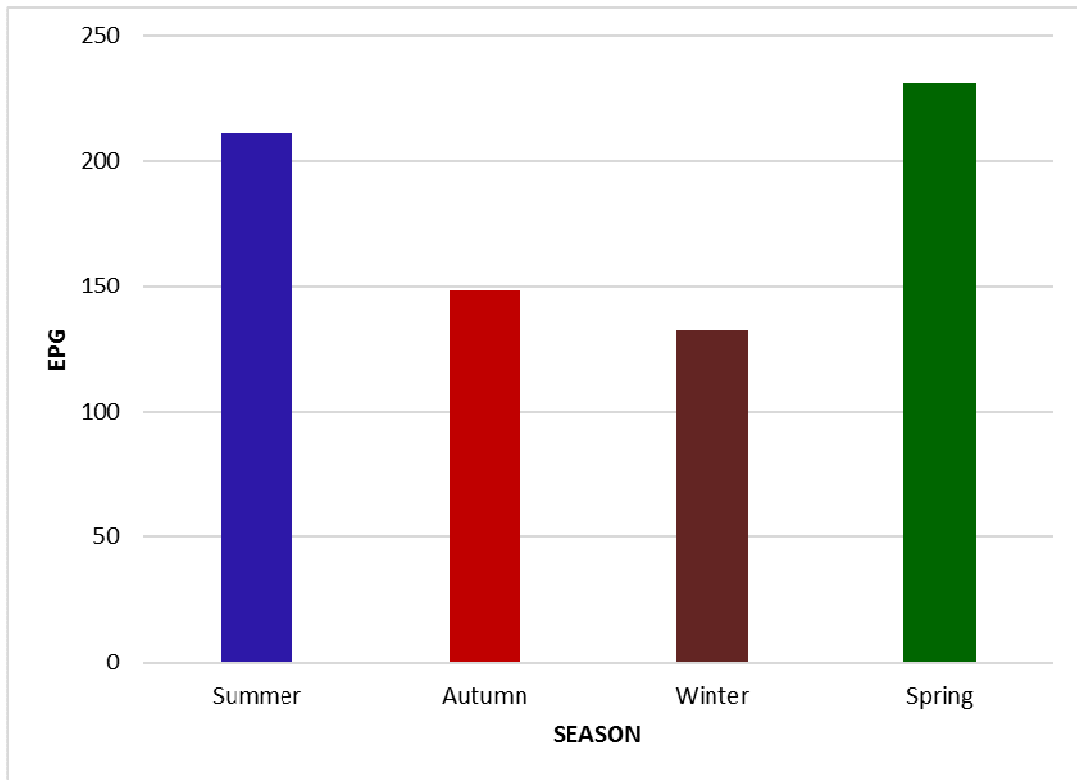


Fig 6: Seasonal comparison of parasitic load of gastrointestinal helminth parasites of cattle in north Kashmir

Table -7: Overall parasitic load of gastrointestinal helminth parasites of cattle in north Kashmir

Age (host)	No. of samples screened	EPG range	Mean EPG
Adult	125	0-400	167.20±89.60 ^a
Young	70	0-400	195.71±9.85 ^b
Total	195	0-400	177.44±6.29

Values with different superscript in a column under a subgroup vary significantly (P<0.05)

Table-8: Sex-wise parasitic load of gastrointestinal helminth parasites of cattle in north Kashmir

Sex (host)	No. of samples screened	EPG range	Mean EPG
Male	67	0-400	153.73±9.82 ^a
Female	128	0-400	189.84±7.91 ^b
Total	195	0-400	177.44±6.29

Values with different superscript in a column under a subgroup vary significantly (P<0.05)

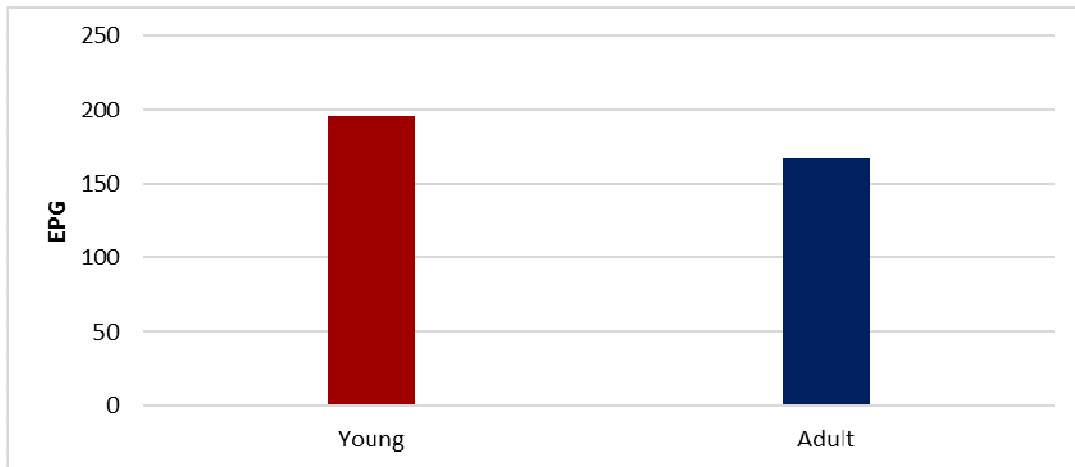


Fig. 7: Overall parasitic load of gastrointestinal helminth parasites of cattle in north Kashmir

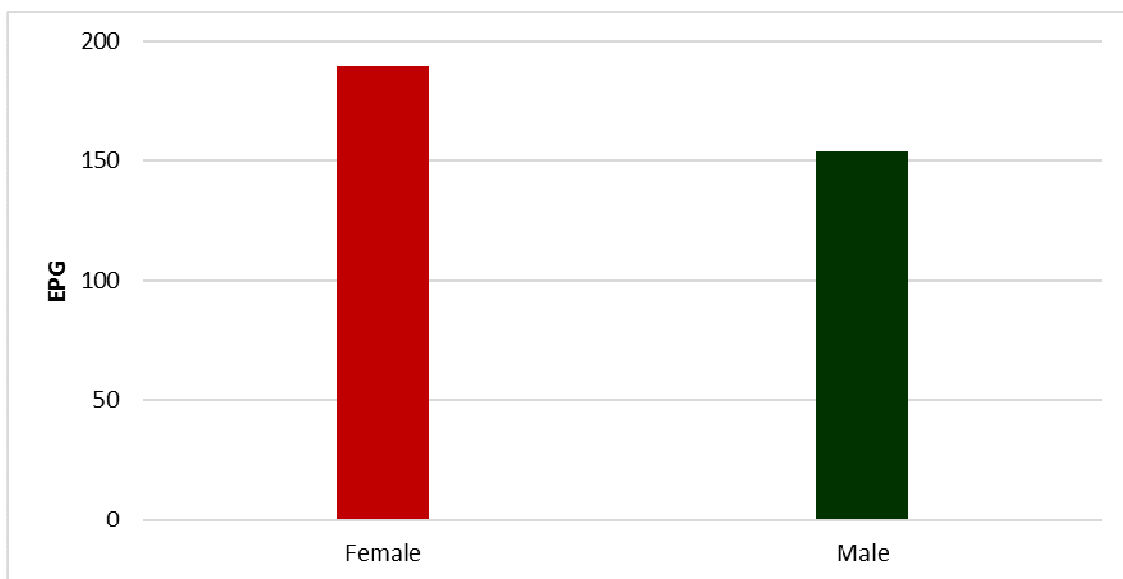


Fig. 8: Sex-wise parasitic load of gastrointestinal helminth parasites of cattle in north Kashmir

4.3 Coproculture examination

A total of 120 faecal samples (30 samples in each season) positive for strongyle eggs were subjected to coproculture examination using petridish method and the third stage larvae were harvested to find out prevalence of different genera of strongyle worms (Plate-2 and Plate-3).

On coprological examination, *Haemonchus* spp. (65%) was found to be most predominant strongyle worm followed by *Bunostomum* spp. (20%) and *Trichostrongylus* spp. (15%).

4.4 Anthelmintic efficacy

Drug trial was conducted in cattle in Rafiabad tehsil of district Baramulla to determine efficacy of commonly used anthelmintics *viz*; ivermectin, fenbendazole and oxcylozanide against gastrointestinal helminth parasites of cattle using faecal egg count reduction test (FECRT) as described by Coles *et al.* (1992)

$$\text{FECR (\%)} = 1 - \frac{X_t}{X_c} \times 100$$

X = A.M of EPG 10-14 days post treatment

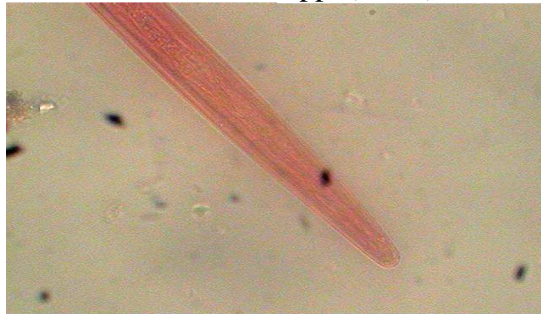
t = treated group

c = control group

A total of 66 animals were selected for the trial. Among these animals, the cattle found positive for nematode infection (strongyle positive animals) and having EPG greater than or equal to 150 were selected and divided into three groups, each comprising of 18 animals (two treatment and one control group). Group 1 animals were treated with ivermectin, group 2 animals with fenbendazole and group 3 animals were kept as untreated infected control.



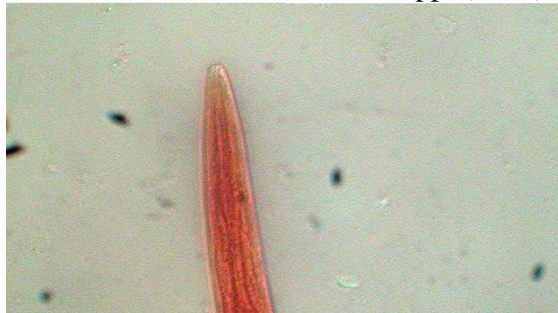
Bunostomum spp. (100X)



Anterior end of *Bunostomum* spp. (400x)

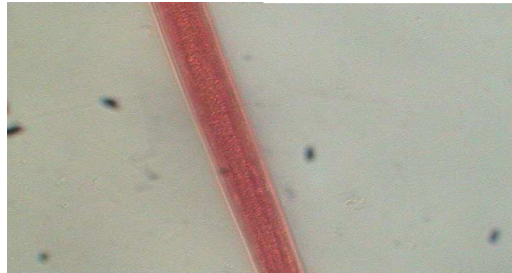


Posterior end of *Bunostomum* spp. (400x)



Anterior end of *Trichostrongylus* spp. (400x)

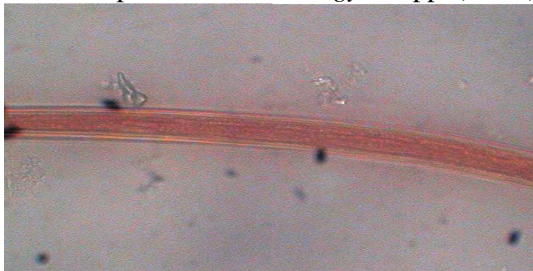
Plate-2 : Coproculture revealing L₃ of *Bunostomum* spp. (larva stains uniformly with iodine, head bullet shaped, Oesophagus with a prominent single bulb caudally, sheath tail prominent) and *Trichostrongylus* spp. (bullet shaped head)



Middle part of *Trichostrongylus* spp. (400X)



Posterior part of *Trichostrongylus* spp. (400X)



Middle part of *Haemonchus* spp. (400X)



Posterior part of *Haemonchus* spp. (400X)

Plate-3 : Coproculture revealing L₃ of *Trichostrongylus* spp. (16 triangular intestinal cells, sheath tail without filament and resembles a pencil tip) and *Haemonchus* spp. (16 rectangular intestinal cells, tuberculated cuticular sheath, kinked tail)

The twelve animals found positive for pure trematode infection (*Fasciola* spp. or Paramphistomes) were divided into two groups. Group 1 comprised of 9 animals (treatment group) and group 2 comprised of 3 animals (control group).

4.4.1 Treatment with Ivermectin (Table-9)

Group 1 animals were treated with ivermectin at the dose rate of 200µg/ kg body weight subcutaneously. Faecal samples were collected from each animal of this group on day 0, 8th and 14th for calculating EPG by Stoll's dilution method. Faecal samples were found positive for ova of strongyle worms only before treatment (day 0)

Pretreatment mean eggs per gram (EPG) of faeces on day 0 was 250.00±16.67. The mean EPG decreased to 0.00±0.00 on day 8th and 14th post treatment.

4.4.1.1 Efficacy of Ivermectin (Table-9, Fig.9)

A total of 100 per cent reduction in faecal egg counts was observed on day 8th and day 14th post treatment against strongyle group of worms.

4.4.2 Treatment with Fenbendazole (Table-9)

Group 2 animals were treated with fenbendazole at the dose rate of 7.50 mg/kg body weight orally. Faecal samples were collected from each animal of this group on day 0, 8th and 14th for calculating EPG by Stoll's dilution method. Faecal samples of all the animals in this group were found positive for ova of strongyle worms only before treatment (day 0).

Pretreatment mean eggs per gram (EPG) of faeces on day 0 was 222.22±10.08. However, on day 8th and 14th post treatment, the total mean EPG decreased to 0.00±0.00.

4.4.2.1 Efficacy of Fenbendazole (Table-9, Fig.9)

It was found that the drug was 100 per cent effective against strongyle worms on 8th and 14th day post treatment.

4.4.2.1.1 Control group (Table-9)

Total 18 animals were selected in control group. Faecal samples were collected from each animal on day 0, 8th and 14th for calculating EPG by Stoll's dilution method. Faecal samples were found positive for ova of strongyle worms. Mean eggs per gram (EPG) of faeces for strongyle worms was 216.67±9.04 on 0 day which increased to 238.89±11.32 on 8th day and on 14th day post treatment EPG again increased to 250.00±12.12.

4.4.3 Treatment with Oxyclozanide (Table-10)

Total 12 cattle were selected and divided into two groups. One group comprised of 3 cattle and served as control while the other 9 animals received treatment with oxyclozanide at the dose rate of 10 mg/kg body weight orally. Faecal samples were collected from each animal of this group on day 0, 8th, 14th and 28th for calculating EPG by Stoll's dilution method. Faecal samples of all animals were found positive for ova of either *Fasciola* spp. or paramphistomes before treatment (day 0).

The total pre- treatment mean eggs per gram (EPG) of faeces on day 0 was found to be 144.44±17.57. Pretreatment mean eggs per gram (EPG) of faeces on day 0 for *Fasciola* spp. and paramphistomes was 66.67±28.87 and 77.78±27.78, respectively. The total mean EPG as well as EPG of *Fasciola* spp. and paramphistomes decreased to 0.00±0.00 on day 8th, 14th and 28th post treatment.

4.4.3.1 Efficacy of Oxyclozanide (Table-10, Fig.10)

A total of 100 per cent reduction in faecal egg counts was observed on day 8th, 14th and 28th post treatment and the efficacy was 100 per cent against *Fasciola* spp. and paramphistomes.

4.4.3.2 Control group (Table-10)

Total three animals were selected in control group. Faecal samples were collected from each animal on day 0, 8th, 14th and 28th for calculating EPG by Stoll's dilution method. Faecal samples were found positive for ova of either *Fasciola* spp. or Paramphistomes. In control group, mean eggs per gram (EPG) of faeces for *Fasciola* spp. and Paramphistomes were 66.67±33.33 and 33.33±33.33 respectively on 0 day which increased to 100.00±0.00 on 8th day and to 133.33±66.66 on day 14th and 28th for *Fasciola* spp. but remained same for paramphistomes.

Table-9: Efficacy of different anthelmintics against nematode parasites (strongyles) of cattle based on faecal egg count reduction test (FECRT)

Group	Anthelmintic	No. of cattle	Mean EPG Day 0	Mean EPG Day 8	FECR %	Efficacy %	Mean EPG Day 14	FECR %	Efficacy %
1	Ivermectin	18	250.00±16.67	0.00±0.00	100	100.00	0.00±0.00	100	100.00
2	Fenbendazole	18	222.22±10.08	0.00±0.00	100	100.00	0.00±0.00	100	100.00
3	Control	18	216.67±9.04	238.89±11.32	-	-	250.00±12.12	-	-

Table-10: Efficacy of “Oxyclozanide” against trematode parasites of cattle based on faecal egg count reduction test (FECRT)

Days	Mean EPG of control (n=3)			Mean EPG of treatment group and per cent efficacy (n=9)		
	F	P	Total	F	P	Total
0	66.67±33.33	33.33±33.33	100.00±00	66.67±28.87	77.78±27.78	144.44±17.57
8	100.00±0.00	33.33±33.33	133.33±33.33	0.00±0.00 (100.00)	0.00±0.00 (100.00)	0.00±0.00 (100.00)
14	133.33±66.66	33.33±33.33	167.67±33.33	0.00±0.00 (100.00)	0.00±0.00 (100.00)	0.00±0.00 (100.00)
28	133.33±66.66	33.33±33.33	167.67±33.33	0.00±0.00 (100.00)	0.00±0.00 (100.00)	0.00±0.00 (100.00)

Figures within parenthesis indicate percentage
F=*Fasciola* spp., P=Paramphistome

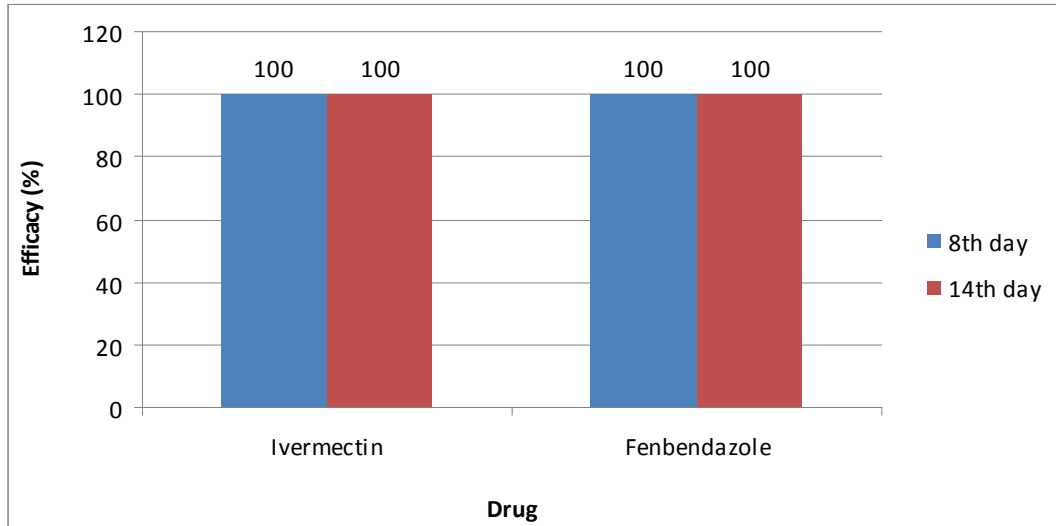


Fig. 9: Efficacy of different anthelmintics against nematode parasites (strongyles) of cattle

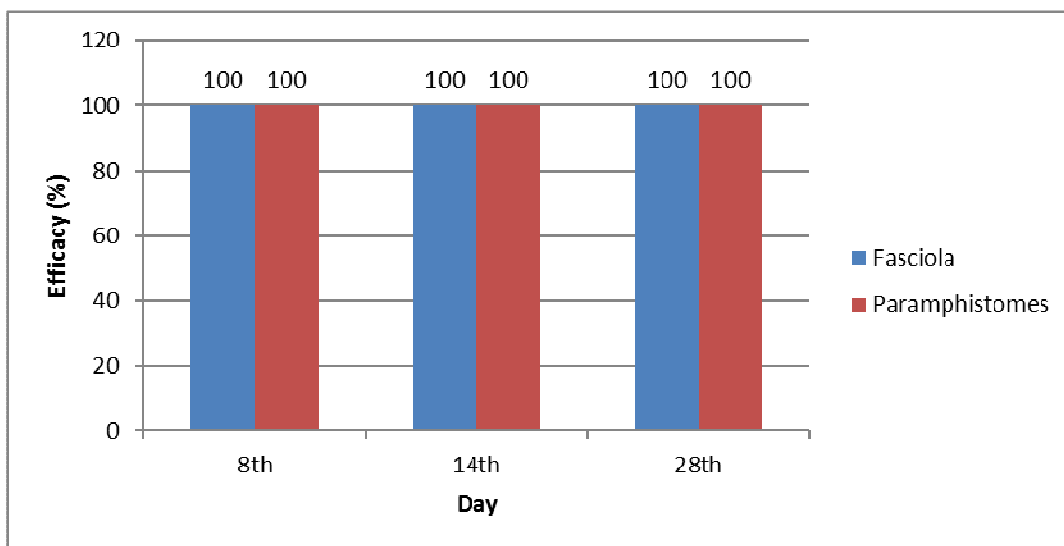


Fig. 10: Efficacy of Oxyclozanide against trematode parasites of cattle

Chapter – 5

DISCUSSION

The epidemiology of gastrointestinal helminth parasites in livestock varies depending on the local climatic conditions and managerial practices. Thus, a need for consistent parasitological surveillance has been recognized all over the world to map out the parasitic fauna on regional basis and to study seasonal variations in their prevalence to evolve package of practices for timely treatment and control to prevent economic losses. Since the control of these parasites in India is mostly undertaken using anthelmintics, therefore, efficacy of commonly used anthelmintics need to be evaluated under field conditions.

Keeping in view the above facts, the present study was undertaken with a purpose to study prevalence and therapeutic aspects of gastrointestinal helminth parasites of locally reared cattle in north Kashmir. The results obtained in this investigation are discussed as under:

5.1 Overall prevalence

In the present study overall prevalence of gastrointestinal helminth parasites in cattle of north Kashmir was found to be 59.86 per cent. Yadav *et al.* (2005) reported the overall prevalence rate of helminth infection as 59.68 per cent in tehsil R.S. Pura of Jammu which is in line with our observation. Almost similar incidence has been reported by Jyoti *et al.* (2011) and Shirale *et al.* (2008) who reported an overall prevalence of 61.40 and 66.28 per cent gastrointestinal parasitic infection in cattle of Punjab and Maharashtra region, respectively. Similarly Mir *et al.* (2013) observed an overall prevalence of 67.15 per cent gastrointestinal parasites in cattle of Jammu (J&K). However, results differed from the study of Laha *et al.* (2013) who recorded comparatively lower prevalence of helminth parasites (28.25%) in central

dry zone of Meghalaya and Kaur and Kaur (2008) who reported an overall prevalence of gastrointestinal parasites of cattle to be 82.35 per cent in Patiala district of Punjab.

Overall prevalence of trematodes was 11.63 per cent. The prevalence of Paramphistomes was highest (7.10%) followed by *Fasciola* spp. (4.53%) and *Dicrocoelium* spp. (0.27%).

The observed prevalence of Paramphistomes is comparable to the findings of Yadav *et al.* (2010) and Hassan *et al.* (2005) who reported prevalence of 13.03 and 3.71 per cent in cattle of Delhi and Punjab, respectively. However the results differed from the study of Singh *et al.* (2008) who reported prevalence of 33.12 per cent in Faizabad. The prevalence of *Fasciola* spp. is comparable to the findings of Sahoo *et al.* (2002) who reported prevalence of 2.11 per cent in grazing cattle of Orissa. However, Ephrem *et al.* (2012) reported a prevalence of 25.2 per cent in Dessie municipal abattoir in Ethiopia. Predominance of Paramphistomes over *Fasciola* spp. has also been reported by Sahoo *et al.* (2002) in Orissa; Mir *et al.* (2003) in south Kashmir; Adhikari *et al.* (2003) in Kathmandu valley of Nepal; Agrawal *et al.* (2004) in Madhya Pradesh; Yadav *et al.* (2005) in Jammu region; Bushra *et al.* (2013) in Kashmir valley and Mir *et al.* (2013) in Jammu region. However, Hafiz *et al.* (2011) reported predominance of *Fasciola* spp. (6.18%) over Paramphistomes (4.04%) in Kashmir valley. Raina *et al.* (1999) and Pandit *et al.* (2004) also reported the predominance of *Fasciola* spp. over Paramphistomes from Jammu region and Kashmir valley, respectively. Lowest prevalence of *Dicrocoelium* spp. (0.5%) was also reported by Akram and Najma (2001) in district Charsaddah of North Western Frontier Province in Pakistan. Pandit *et al.* (2004) and Bushra *et al.* (2013) also reported lowest prevalence of *Dicrocoelium* spp. in comparison to Paramphistomes and *Fasciola* spp.

The reason for low prevalence rate of snail borne trematodal infection can be attributed to the fact that the maximum animals are either stall fed or grazed in apple orchards, hence minimizing the chances of exposure to the infective metacercarial stages present on the vegetation in the vicinity of water bodies.

Among cestodes the only genus reported was *Moniezia* spp. with prevalence of 4.44 per cent. Almost similar prevalence rate of 4.8 and 4.10 per cent was reported by Jimenez *et al.* (2007) and Bushra *et al.* (2013) from dairy and beef farm in Costa Rica and central zone of Kashmir valley, respectively. However Hirani *et al.* (1999) observed a prevalence rate of 0.11 per cent in Kheda district of Gujarat. Eggs of *Stilesia* spp. and *Avitellina* spp. were not found on faecal examination because it is difficult to find their eggs in faeces as they are contained in thick walled par uterine organs (Bhatia *et al.*, 2004), therefore, their presence cannot be ruled out.

Overall prevalence of nematode parasites in present study was 53.02 per cent. Among nematodes, maximum prevalence was of strongyle worms (49.91%) followed by *Trichuris* spp. (3.64%) and *Strongyloides* spp. (2.04%). The results of present investigation are in close approximation to the findings of Shirale *et al.* (2008) who reported an overall prevalence of nematode parasites to be 58.00 per cent in western Vidarbha region of Maharashtra. The prevalence of strongyle worms in the present study are in general agreement with Chowdhury *et al.* (1993) who reported the prevalence of strongyle worms to be 52.20 per cent in Dhaka. However Mamatha and D'souza (2006) in Bangalore reported the prevalence of strongyle worms to be 83.6 per cent. Similarly, predominance of strongyle group of worms over the other nematodes noted in present study has also been reported by Chowdhury *et al.* (1993) in Dhaka; Pandit *et al.* (2004) in Kashmir valley; Yadav *et al.* (2005) in R.S Pura, Jammu; Jimenez *et al.* (2007) in Costa Rica; Chavhan *et al.* (2008) in Nagpur;

Degefu *et al.* (2011) in Ethiopia and Bushra *et al.* (2013) in central zone of Kashmir valley.

Lower prevalence of *Strongyloides* spp. could be due to development of immunity against parasite as little exposure of *Strongyloides* infection leads to marked immunity (Soulsby, 1982). These findings are in line with Chowdhury *et al.* (1993) who reported higher prevalence of *Trichuris* spp. (5.5%) compared to *Strongyloides* spp. (2.5%). Palamapalle *et al.* (2003) also reported higher prevalence of *Trichuris* spp. (4.22%) compared to *Strongyloides* spp. (2.88%). Similarly, Bushra *et al.* (2013) also reported higher prevalence of *Trichuris* spp. (5.41%) in comparison to *Strongyloides* spp. (3.85%)

The highest prevalence of nematodes particularly strongyle worms in the present study is because of the fact that these worms are prolific egg layers and take lesser time for completion of life cycle and thus grazing areas become heavily infected with the larvae of strongyle worms within a period of fortnight.

5.2 Seasonal Prevalence

The seasonal prevalence of overall gastrointestinal helminth parasites was higher in spring season (68.21%) followed by autumn (67.50%), summer (55.59%) and winter (48.21%). Our results are in agreement with the findings of Sreedevi (2012) who recorded highest prevalence in spring and lowest in winter season in and around Tirupati, Andhra Pradesh. Similarly Yadav *et al.* (2005) observed the highest prevalence of helminthic infection in rainy season. Low prevalence in winter season is due to hypobiosis and overwintering of parasitic stages because of lowered environmental temperatures. Similarly the higher prevalence in spring season is due to resumption of development of hypobiotic larvae as well as overwintered larvae in grazing areas.

The prevalence of trematodes was found higher in autumn and spring season each showing prevalence of 13.93 per cent followed by winter (11.07%) and summer (7.69%). The results are in agreement with findings of Sardar *et al.* (2006) who reported highest prevalence of trematodes in spring season and Khan and Maqbool (2012) who reported highest prevalence in autumn. Prevalence of Paramphistomes was also found highest in autumn and spring season (9.29% in each season). The reason can be attributed to the fact that during spring and autumn environmental conditions in Kashmir valley are very favourable for hatching of ova, the viability of encysting metacercariae and survival of snails. Prevalence of *Fasciola* spp. was found highest in winter season followed by spring, autumn and summer season. Higher prevalence rate of *Fasciola* spp. in winter season and low intensity during autumn and summer has also been reported by Roy and Tondon (1992) and Bushra *et al.* (2013). Least prevalence in summer has also been reported by Yadav *et al.* (2005) and Khan and Maqbool (2012). The reason for highest prevalence in winter is due to the fact that environmental conditions in Kashmir in autumn are very favourable for hatching of eggs and survival of metacercariae of *Fasciola* spp. The animals actually pick up the infection during autumn and parasites reach to sexual maturity in bile ducts during winter after migrating through the peritoneal cavity and liver parenchyma and therefore egg detection becomes possible. *Dicrocoelium* spp. was found in winter (0.71%) and summer (0.35%) season only.

Moniezia spp. showed higher prevalence of 6.07 per cent in autumn, followed by spring (5.00%), summer (3.85%) and winter (2.86%).

Prevalence of nematodes was found higher in spring season (60.00%) followed by autumn (59.64%), summer (53.50%) and winter (38.93%). The results are in agreement with the findings of Sultana *et al.* (2013) who reported prevalence of nematode infection highest in spring followed by autumn, summer and winter. The

highest incidence of nematode infection in spring is due to resumption of development of hypobiotic larvae and availability of overwintered larvae on herbage and availability of larvae which hatch from freshly laid eggs by infected animals (spring rise phenomenon).

5.3 Age-wise Prevalence

In the present study, it was observed that overall gastrointestinal helminth infection was lower (55.10%) among adults as compared to young cattle (68.13%). Our results are in agreement with those of Biu *et al.* (2009), Akter *et al.* (2011), Haque *et al.* (2011) and Bushra *et al.* (2013) who also reported higher prevalence of helminths in young cattle compared to adult cattle in Nigeria, Bangladesh, Western Punjab and Kashmir valley, respectively

Higher prevalence of trematodes reported in adults (14.69%) in present study is in agreement with the findings of Chowdhury *et al.* (1993) in Bangladesh; Yadav *et al.* (2005) in Jammu region and Bushra *et al.* (2013) in Kashmir valley. This can be due to the reason that young animals are less grazed in water logged areas compared to adult, as a result having less exposure to infective stages of trematodes. It is also because of built up of infection in adults due to repeated exposure. Prevalence of *Fasciola* spp. and Paramphistomes were more in adults (5.87 and 8.95%) than young cattle (2.19 and 3.89%). These findings are in conformity with observation of many workers (Chowdhury *et al.* 1993; Sardar *et al.* 2006; Paul *et al.* 2011; Khan and Maqbool, 2012 and Bushra *et al.* 2013). *Dicrocoelium* spp. was also found higher in adults (0.28%) in comparison to young cattle (0.24%). This might also be due to built up of infection due to repeated exposure.

Contrary to trematodes overall *Moniezia* spp. infection was more prevalent in younger group (6.33%) as against 3.36 per cent in adult age group. Sardar *et al.*

(2006) also reported higher *Moniezia* spp. infection in calves as compared to adult cattle. Higher prevalence of *Moniezia* spp. in young cattle has also been reported by Bushra *et al.* (2013) in Kashmir valley; Haque *et al.* (2011) in western plains of Punjab and Singh *et al.* (2008) in Faizabad. However results differed from that of Raza *et al.* (2013) who reported higher prevalence of *Moniezia* spp. in adult cattle in Pakistan. It is a universally accepted fact that lambs, kids and calves under six months of age are substantially infected by tapeworms in general and *Moniezia* spp. in particular as compared to adults due to development of immunity by the later.

Prevalence of nematodes was found higher in young cattle (63.75%) in comparison to adult cattle (46.85%). These findings are in accordance with Yadav *et al.* (2005), Pfukenyi *et al.* (2007), Awraris *et al.* (2012) and Bushra *et al.* (2013) who recorded higher prevalence of gastrointestinal nematodes in calves than the adults. Strongyle worms were also found higher in young cattle (58.88%) in comparison to adults in which prevalence was 44.76 per cent. These findings are in line with the findings of Holland *et al.* (2000) in Vietnam; Singh *et al.* (2008) in Faizabad and Bushra *et al.* (2013) in Kashmir valley. *Strongyloides* spp. and *Trichuris* spp. followed similar pattern with higher prevalence in young cattle (3.16% and 6.33%) in comparison to adults (1.40% and 2.10%). These findings are also in conformity with findings of Yadav *et al.* (2005), Singh *et al.* (2008) and Bushra *et al.* (2013). The low incidence of nematode infection in adults as compared to younger animals is due to development of age resistance.

5.4 Sex wise prevalence

In the present study, the overall prevalence was found higher in females (60.56%) compared to males (58.24%). Trematode infection was also found higher in females (12.85%) in comparison to males (8.82%). *Fasciola* spp. and Paramphistomes followed the similar pattern unlike *Dicrocoelium* spp. which was

found non-significantly ($P>0.05$) higher in males. Current findings are in line with the study of Chowdhury *et al.* (1993), Singh *et al.* (2008) and Bushra *et al.* (2013) who also observed higher prevalence of trematodes in females as compared to males. Higher prevalence of parasitic infection in females in general is due to physiological stresses like pregnancy and lactation which results in temporary relaxation in immunity.

Moniezia spp. was also found higher in females (4.96%) compared to males (3.24%). Bushra *et al.* (2013) and Raza *et al.* (2013) also found prevalence of *Moniezia* spp. higher in females compared to males. However, prevalence of nematodes in the present study was found non-significantly ($P>0.05$) higher in males (54.71%) in comparison to females (52.29%). Our findings are in agreement to that of Chowdhury *et al.* (1993) and Bharkad *et al.* (1999) who also observed higher prevalence of nematodes in males.

5.5 Parasitic load

Average EPG of 195 faecal samples examined was found to be 177.44 ± 6.29 . (EPG range: 0-400). Average EPG was found highest in spring season, 231.11 ± 14.15 (EPG range: 0-400) followed by summer, 211.11 ± 11.56 (EPG range: 0-300), autumn, 148.00 ± 11.15 (EPG range: 0-300) and winter, 132.73 ± 8.32 (EPG range: 0-200). This observation goes in agreement with Bushra *et al.* (2013) who observed highest average EPG in spring season. This is due to spring rise phenomenon because the larvae of most of the strongyle worms undergo arrested development within the body of host in winter season and in spring when environmental conditions are favourable, these larvae mature to adults leading to increase in egg production.

In young cattle eggs per gram of faeces ranged from 0-400 with an average EPG of 195.71 ± 9.85 and in adults eggs per gram of faeces ranged from 0-400 with an

average EPG of 167.20 ± 89.60 . Average EPG was found significantly higher in young cattle as compared to adults. Our findings are in agreement with Bushra *et al.* (2013) who also found higher infection in young cattle as compared to adult animals. This might be due to the development of acquired immunity by the adults as compared to young ones in which immune system is not yet fully developed.

In females eggs per gram of faeces ranged from 0-400 with an average EPG of 189.84 ± 7.91 and in males eggs per gram of faeces ranged from 0-400 with an average EPG of 153.73 ± 9.82 . The reason for higher EPG in females is because females experience periparturient and post-parturient rise in faecal egg counts due to pregnancy and lactation stress. In lactating animals there is also marked increase in susceptibility to newly acquired infection (Shubber *et al.*, 1981).

5.6 Coprocultural studies

On coprocultural examination, *Haemonchus* spp. (65%) was found to be most predominant strongyle worm followed by *Bunostomum* spp. (20%) and *Trichostrongylus* spp. (15%).

Predominance of *Haemonchus* spp. over other strongyle worms has also been reported by Waruiru *et al.* (1998) in Kenya; Borthakur and Das (1998) in Assam; Mondal *et al.* (2000) in Mymensingh, Bangladesh; Yadav *et al.* (2008) in Uttarakhand and Bushra *et al.* (2013) in Kashmir valley, respectively. This is because of the fact that the females of *Haemonchus* spp. are prolific egg layers (Urquhart, 1996) and infective stages of *Haemonchus* spp. survive for prolonged periods on pastures. (Soulsby, 1982). However, Jitendran and Bhat (1999) has reported predominance of *Trichostrongylus* spp. over *Haemonchus* spp. in Himachal Pradesh. Similarly, Mamatha and D'Souza (2006) has reported predominance of *Bunostomum* spp. over other strongyle worms in cattle and buffaloes of Bangalore.

5.7 Evaluation of commonly used anthelmintics under field condition

In the present study, percent reduction in egg counts with ivermectin and fenbendazole against nematodes (strongyle worms) and with oxclozanide against trematodal infection (*Fasciola* spp. and Paramphistomes) was recorded as 100.00 per cent. As per Coles *et al.* (1992) these values suggest that all the above three drugs are effective against the respective parasitic infections of cattle in Rafiabad tehsil of district Baramulla of north Kashmir as the criteria for efficacy i.e. FECR% is more than 95.00 per cent and there is no evidence of development of resistance against these drugs by the respective helminth parasites.

Ivermectin was found to be 100 per cent effective against strongyle worms on 8th and 14th day post treatment. Our observation is in agreement with Kumar *et al.* (2004) who also found ivermectin @ 200µgm/kg body weight to be 100 per cent effective in controlling natural gastrointestinal nematodosis in cattle after 7 days post treatment and upto 20 days in Ranchi. Our observations are also in close agreement with Sarkar *et al.* (2005) who found efficacy of ivermectin against gastrointestinal nematodes to be 100, 100 and 95.8 per cent on 7th, 21st and 30th day, respectively, in Bangladesh. Gill *et al.* (1989) also observed complete elimination of gastrointestinal nematodes of cattle within one week of treatment with ivermectin. Bushra (2010) also observed 100 per cent efficacy of ivermectin against strongyle worms of cattle on 7th and 14th day post treatment in Kashmir valley. Similarly, Ahmed *et al.* (2007) observed 100 per cent efficacy of ivermectin on 14th day post treatment against gastrointestinal nematodes in naturally infected cattle of Assam.

Fenbendazole was found to be 100 per cent effective against strongyle worms on 8th, and 14th day post treatment. Our results regarding the efficacy of fenbendazole against strongyle worms are in agreement with those reported by Geerts *et al.* (1987) in Flanders; Williams and Broussard (1995) in USA and Bushra (2010) in central

Kashmir, who reported 100 per cent efficacy of fenbendazole against gastrointestinal nematode infection in cattle.

Oxyclozanide was found to be 100 per cent effective against trematodal infection (*Fasciola* spp. and Paramphistomes) on 8th, 14th and 28th day post treatment. Our findings are in close proximity with the study of Arias *et al.* (2013) who observed faecal egg count reduction value of 97-99 per cent against Paramphistomes in dairy cattle of Spain when treated with oxyclozanide. Similar findings were made by Shokier *et al.* (2013) who found 100 per cent reduction in faecal egg count on 14th day post-treatment of oxyclozanide against *Fasciola* spp.

Chapter – 6

SUMMARY & CONCLUSION

The present study on prevalence of gastrointestinal helminth parasites of cattle was carried out in locally reared cattle in north zone of Kashmir valley (Baramulla, Kupwara and Bandipora districts) from July 2013 to June 2014. A total of 1126 faecal samples were screened from cattle of either sex and of both the age groups viz. adult cattle (age>1 year) and young cattle (age<1 year) comprising of 286 samples in summer and 280 samples each in autumn, winter and spring season. The therapeutic efficacy of ivermectin, fenbendazole and oxclozanide against these helminth parasites of cattle was also evaluated in present study.

The results obtained in the present investigation are summarized as:

- Based on examination of 1126 faecal samples of locally reared cattle an overall prevalence of gastrointestinal helminth infections was found to be 59.86 per cent with trematodes, cestodes and nematodes found in 11.63, 4.44 and 53.02 per cent animals, respectively.
- Eggs of various helminths encountered in the present study were those of *Fasciola* spp. (4.53%), *Dicrocoelium* spp. (0.27%), Paramphistomes (7.10%), *Moniezia* spp. (4.44%), strongyle worms (49.91%), *Strongyloides* spp. (2.04%) and *Trichuris* spp. (3.64%).
- A higher prevalence of gastrointestinal helminth parasites was found in spring (68.21%) followed by autumn, summer and winter in which prevalence rate was 67.50, 55.59 and 48.21 per cent respectively, the variation being statistically significant ($P<0.05$) between summer and autumn, summer and spring, autumn and winter, spring and winter.

- Paramphistomes showed highest prevalence in autumn and spring (9.29% in each season) followed by summer (5.59%) and winter (4.29%), the variation being statistically significant ($P < 0.05$) between summer and autumn, summer and spring, autumn and winter, spring and winter.
- *Fasciola* spp. revealed a different seasonal activity with a higher prevalence of 6.43 per cent in winter followed by 5.36, 4.64 and 1.75 per cent in spring, autumn and summer respectively, the variation being statistically significant ($P < 0.05$) among summer and autumn, summer and winter, summer and spring.
- *Dicrocoelium* spp. was not found in autumn and spring season. Highest prevalence of *Dicrocoelium* spp. was found in winter (0.71%) followed by summer (0.35%) but the variation was statistically non-significant ($P > 0.05$).
- Prevalence of *Moniezia* spp. was found highest in autumn (6.07%) followed by spring (5.00%), summer (3.85%) and winter (2.86%), variation among seasons was statistically non-significant ($P > 0.05$).
- The prevalence of strongyle worms was highest in autumn (56.79%) followed by spring (55.36%), summer (50.35%) and winter (37.14%), the variation being statistically significant ($P < 0.05$) between winter and summer, winter and autumn, winter and spring.
- *Trichuris* spp. showed a higher prevalence rate in autumn (5.36%), followed by spring (4.29%), summer (3.50%) and winter (1.43%), the variation being statistically significant ($P < 0.05$) between autumn and winter, winter and spring.
- Highest prevalence of *Strongyloides* spp. was found in spring (3.21%) followed by summer (2.45%), autumn (1.79%) and winter (0.71%). The variation was statistically significant ($P < 0.05$) between winter and spring.

- Significantly ($P < 0.05$) higher prevalence rate of trematodes encountered in present study was observed in adults (14.69%) compared to young cattle (6.33%). *Fasciola* spp. and Paramphistomes were also found significantly ($P < 0.05$) higher in adults (5.87 & 8.95%) in comparison to young ones (2.19 & 3.89%). Prevalence of *Dicrocoelium* spp. was found non-significantly ($P > 0.05$) higher in adults (0.28%) in comparison to young cattle (0.24%).
- *Moniezia* spp. showed a higher prevalence in young cattle (6.33%) compared to 3.36 per cent in adult cattle, the variation being statistically significant ($P < 0.05$).
- All the nematodes encountered in present study i.e. strongyle worms, *Strongyloides* spp. and *Trichuris* spp. were found significantly ($P < 0.05$) higher in young cattle with prevalence rates of 58.88, 3.16 and 6.33 per cent as compared to adult cattle with prevalence rates of 44.76, 1.40 and 2.10 per cent, respectively.
- The prevalence of trematodes was found non-significantly ($P > 0.05$) higher in females (12.85%) compared to males (8.82%). *Fasciola* spp. and paramphistomes were found higher in females with prevalence rate of 4.71 and 8.14 per cent compared to males in which prevalence rates were 4.12 and 4.71 per cent respectively, the variation being statistically non-significant ($P > 0.05$) for *Fasciola* spp. and significant ($P < 0.05$) for paramphistomes. *Dicrocoelium* spp. showed a different activity with a higher prevalence rate of 0.29 per cent in males compared to females (0.25%), the variation being statistically non-significant ($P > 0.05$).
- *Moniezia* spp. showed a higher prevalence in females (4.96%) as compared to males (3.24%), the variation being statistically non-significant ($P > 0.05$).
- All the nematodes encountered in the present study i.e. strongyle worms, *Strongyloides* spp. and *Trichuris* spp. were found non-significantly ($P > 0.05$)

higher in males with prevalence rates of 53.24, 2.06 and 3.82 per cent as compared to females with prevalence rates of 48.47, 2.04 and 3.56 per cent, respectively.

- Overall prevalence of mixed gastrointestinal helminth parasites was found to be 11.90 per cent. Mixed infection was found more in autumn (16.07%) followed by spring (14.29%), summer (12.24%) and winter (5.00%). The variation was statistically significant ($P < 0.05$) between summer and winter, autumn and winter, spring and winter.
- Mixed infection was found higher in young cattle compared to adults and higher in males compared to females but the variation was statistically non-significant ($P > 0.05$).
- EPG of 195 samples determined in present study ranged from 0-400 and an average EPG count was found to be 177.44 ± 6.29 . Parasitic load was found highest in spring (231.11 ± 14.15) followed by summer (211.11 ± 11.56), autumn (148.00 ± 11.15) and winter (132.73 ± 8.32). The variation was statistically significant ($P < 0.05$) between summer and autumn, summer and winter, autumn and spring, winter and spring.
- Parasitic load was found higher in young cattle (195.71 ± 9.85) as compared to adults (167.20 ± 89.60), the variation being statistically significant ($P < 0.05$).
- Parasitic load was found higher in females (189.84 ± 7.91) as compared to male animals (153.73 ± 9.82), the variation being statistically significant ($P < 0.05$).
- On coprological examination, *Haemonchus* spp. (65%) was found to be most predominant strongyle worm followed by *Bunostomum* spp. (20%) and *Trichostrongylus* spp. (15%).
- Ivermectin and fenbendazole were found to be 100.00 and 100.00 per cent respectively effective against strongyle worms as revealed by FECRT on 8th and 14th day post treatment.

- Oxyclozanide was found to be 100.00 per cent effective against *Fasciola* spp. and Paramphistomes on 8th, 14th and 28th day post treatment.

CONCLUSION

- Since highest prevalence of *Fasciola* spp. was found in winter season which indicates that animals pick up the infection during late summer and autumn seasons. Therefore, prophylactic dosing of animals during late autumn will be very useful in preventing liver damage and losses caused due to fasciolosis. Similarly, prophylactic dosing of animals in late winter or early spring will be useful in reducing pasture contamination with *Fasciola* spp. eggs.
- Since the nematode infection was found higher in autumn and spring, therefore, prophylactic dosing of animals in autumn and spring will be very much useful in preventing production losses.
- However, it will be better to use a drug combination which is effective against trematodes, cestodes as well as nematodes.

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CERTIFICATE

Certified that all the corrections/amendments as suggested by External Examiner, Dr. Sankar Muthu, Scientist (Senior Scale), Division of Temperate Animal Husbandry, Indian Veterinary Research Institute, Mukteswar, Nainital, Uttarakhand during Viva –voce examination held on 20th of October, 2014 have been incorporated in the manuscript entitled **“Epidemiological and Therapeutic Studies on Gastrointestinal Helminth Parasites of Cattle in North Kashmir”** submitted by **Dr. Aiman Ashraf (Regd. No. 2012-V-186-M)**.

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