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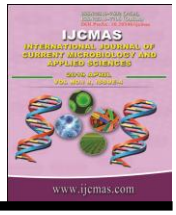

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# Gastrointestinal Nematodiasis with Main Emphasis on *H.contortus* Infection in Small Ruminants

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**A B S T R A C T**

Small ruminant farming serves as a major source of livelihood in rural areas where about 70% of the population is dependent on agricultural and livestock related activity. In spite of so high potential of these animals, production is significantly constrained due to disease caused by variety of pathogens that include bacteria, virus, protozoa and helminths. Among all these pathogens, parasites are the major cause of sub clinical cases which are not readily diagnosed in field conditions hence affecting production and economic status. These internal parasites cause prolonged and long term effects on animal health and wellness. A reduction in growth rate by 1/3rd is reported due to helminthic infestation in ruminants. Gastrointestinal nematodes that infect small ruminants mainly fall under Family *Trichostrongylidae* that consists of many pathogenic nematodes; most important among these is *Haemonchus contortus*. Pathogenesis of *H. contortus* is mainly correlated to its haematophagus nature leading to anaemia and high prolificacy causing rapid build-up of infection in the environment. Following review provides a general insight into gastrointestinal nematode parasitism and helps in better understanding of pathogenesis of haemonchosis.

## Introduction

India is primarily an agricultural country with about 70% of total income from farm and livestock related activities. Sheep and goat farming is a major source of livelihood for small, marginal scale farmers and landless labourers. These animals have been reared since decades for milk, meat, hair and skin around the globe. According to the Food and Agriculture Organisation (FAO, 2013) overall sheep population for the year 2012 was 1.2 billion worldwide, dominated by Asia (44.9%), followed by Africa (27.6%) and America (7.3%). Sheep and goat population as recorded in 19th livestock census was 65.07 million and 135.17 million, respectively. Internal parasites represent an important cause of disease and loss in production for Sheep and Goat farming. A considerable loss to animal husbandry is caused due to the infection/diseases caused by these parasitic nematodes.

## General epidemiology and pathogenesis

Gastrointestinal parasitism (GIP) is usually caused due to mixed infections with several

species of the nematodes. Gastro intestinal helminthic infestation is widespread occurring more commonly in tropical and sub-tropical areas. In the past few years the incidence has increased and in India infection reported from ruminants ranged in between 25-78% (Bandyopandhyay *et al.,* 2010).

GIP incidence is more common in animals reared in open pastures and low cases are obtained from stall fed animals. Infectious stages of the parasites are present in nature and can be transmitted to host animal through ingestion of contaminated pastures and water sources. Infections with these GIT nematodes rarely cause mortality however indirect production and productivity losses are more pronounced.

Infection is more severe and is the cause of fatal disease outcome in animals reared in semi-intensive and free range farming systems. Parasitic nematodes (roundworms) have varied health and economic effects on the productivity and well-being of livestock worldwide. The incidence of helminthic infection varies with the age, sex, season, nutritional status, managemental practices and prevailing agro climatic conditions.

## Economic effects

Harmful effects caused by these parasites are in terms of direct and indirect losses. Pathology caused by these gastrointestinal (GI) parasites is varied (Souls by, 1982) and disease occurrence is mainly dependent on many factors that include interactions between environment, host and parasite Ill effects due to these parasites are mainly in terms of reduced growth rates, decreased milk, meat, fibre quality and additional cost incurred for the treatment of these infections. India being a tropical country faces a major turn over due to these helminthic infections. Monsoon rains combined with availability of suitable climatic conditions sustain propagation and multiplication of these parasitic worms.

Parasitism has indirect effects on animal health by diversion of energy required for normal physiological metabolism to synthesis of various cytokines and immune mediators required for clearing up the established infection. Other symptoms include reduced feed intake due to anorexia and increased susceptibility to other pathogens (Sykes and Coop, 2001; Moreau *et al.,* 2010). Changes in body composition of affected animals occur, thereby making animals more susceptible to other concurrent infections (Dominguez-Torano *et al.,* 2000).

Most of the nematodes that infect gastrointestinal tract of ruminants belong to the family *Trichostrongylidae*. Among these *Haemonchus contortus*, *Trichostrongylus colubriformis* are highly evolved and are major production limiting factor in sheep. Other species involved are *Cooperia*, *Nematodirus*, *Oesophagostomum*, *Chabertia ovina*, *Bunostomum trigonocephalum*, *Skrjabinema ovis* and *Trichuris* spp. Disease caused by these parasites is varied in nature with clinical signs ranging from diarrhoea, constipation, weakness, decreased growth/production rates and reduced wool/fibre quality. Combined effect of these parasites leads to growth retardation with prolonged debility condition in affected animals. As no farm animal is free from these gut parasites and get infected by these once in their lifetime, hence making deworming an essential component of farm management programme.

## Haemonchosis

Among all gastrointestinal parasites most pathogenic and widely prevalent gut nematode in sheep and goat is

*Haemonchuscontortus*, the blood feeding abomasal parasite. Haemonchosis caused by *H. contortus* represents ~15% of all gastrointestinal diseases of small ruminants world-wide and results in extensive financial losses.

In India three species have been reported viz., *H. contortus* (Sheep, goat, cattle and other ruminants), *H. similis* (cattle, deer) and *H.longistipes* (camel). Estimated losses due to the treatment in India alone for *Haemonchus contortus* is $103 million (Waller and Chandrawathani, 2005). *Haemonchus* is among the most fecund strongylid nematodes with a pre patent period of 18-21 days. Adult female lays about five thousand eggs per day that are passed out in the faeces of affected animal leading to pasture contamination. No association between age and animal class exist regarding disease occurrence however haemonchosis is more common in lactating ewes and young lambs due to relaxtion of immunity and absence of maternal antibodies to stop upcoming infection (Taylor *et al.*, 2007).

Clinical haemonchosis is mainly classified into three types depending upon intensity of worm burden that is hyper acute, acute and chronic form (Souls by, 1982; Taylor *et al.*, 2007). Hyper acute haemonchosis occurs due to sudden massive uptake of large doses of infective $L_3$ larvae. It is less common in nature and leads to haemorrhagic anaemia causing dark coloured faeces and sudden death due to acute blood loss. This form is most common in lambs and lactating ewes due to break in the immunity. Animal is usually found dead without any preliminary signs. The possible pathogenic mechanism, which is responsible for cause of death in haemonchosis is hemorrhagic anaemia, hypoproteinemia and oedema due to vital blood sucking by both $L_4$ and adults. Moreover, diarrhoea causes fluid loss and dehydration resulting in hypovolaemic shock. Infected animals become progressively weak and are reluctant to move with the development of bottle jaw condition as a result of submandibular oedema.

Le Jambre (1995) reported that a close positive correlation exists between number of parasity and severity of infection. In chronic cases, symptoms similar to malnutrition as depicted by poor weight gain, break in wool are prominent due to excessive blood loss. However, compensatory mechanism occur but in the absence of proper treatment bone marrow continuously gets exhausted as a result of loss of iron and proteins in tract leading to death. Daily loss in weight upto 30g/day has been reported in sheep and goat infected with small but prolonged cases (Beriajaya and copeman, 2006).

On post mortem examination pin point haemorrhages can be seen on abomasa mucosa which is oedematous. There is presence of thin barber pole like worms with are about 2 cm in length on entire mucosa. Presence of frank blood is evident on mucosal surface with pale mucus membranes and ascites condition.

Main economic losses are due to reduced weight gain and prolonged emaciation because of impaired digestion and decreased absorption of protein, calcium and phosphorus (Sood, 1981). About 30-40% mortality has been reported in lambs due to haemonchosis if no timely treatment with proper anthelmintic is undertaken (Kalita *et al.*, 1978).

The presence of *H. contortus* in the abomasum appears to interfere with the digestion and absorption of proteins, calcium and phosphorus (Sood, 1981). Increased susceptibility to *Haemonchus* infection in goats has been reported in animals with

vitamin A and calcium defeciencies (Kumar and Deo, 1970).

Disturbance in the levels of various haematological and biochemical parameters have been observed in clinical haemonchosis. Drop in hemoglobin, haematocrit (PCV), TEC, RBC level, serum protein and albumin is more pronounced in affected animals (Ijaz *et al.,* 2009).Infection with *H. Contortus* produces serious effect on serum biochemistry and enzymatic assays particularly the change in the levels of acidic phosphate, alkaline phosphate (ALP), aspartate aminotransferase (AST) or serum glutamate oxalate transaminase (SGOT) and alanine aminotransferase (ALT) or serum glutamate pyruvate transaminase (SGPT) (Hassan *et al.,* 2013).

Various laboratory tests have been employed for the diagnosis of the condition. Most common among these is faecal flotation followed by egg counting by modified McMaster technique to know severity of the infection. Faecal culture to differentiate various nematode larvae is widely accepted. In this larvae are morphologicaly differentiated and identified as per the standard keys provided by various workers (Yamaguti, 1960; Soulsby, 1982 Van Wyk and Mayhew, 2013)

Due to high pathogenicity and wide prevalence of haemonchosis, various control measures have been adopted, which involve both chemical and non-chemical control measures. Despite availability of combination of various anthelmintics along with pasture and grazing management, *H.contortus* remains major threat to sheep and goat industry. This is due to development of resistance to many of the commercially available anthelmintics. Current control strategies against *H. contortus* are mainly by use of anthelmintic drugs. However, widespread use of anthelmintics has led to serious drug resistance problems in domestic animals worldwide (Kaplan and Vidyashankar, 2012). A new class of anthelmintic, the aminoacetonitrile derivatives introduced recently like monepantel, have also reported to acquired resistance (Scott *et al.,* 2013).

Hence, due to widespread anthelmintic resistance and demand for clean, green, residue free animal products, there is need for alternative approach to combat haemonchosis. Under IPM (Integrated pest management) combination of various anthelmintics along with other nonchemical methods are used. This includes grazing management, nutritional management, genetic selection or breeding methods (Kelly *et al.,* 2013), biological control by use of medicinal plants (Iqbal *et al.,* 2007), use of nematophagus fungi (Waller and Larsen, 1993; Larsen, 2000) and strategic treatment of the affected animals by anaemia assessment using FAMACHA (van Wyk and Bath, 2002; Kaplan *et al.,* 2004).

Selective treatment of individual animals instead of treating all animals is another economic strategy for control of *H. contortus*. The FAMACHA system, which involves comparison of conjunctival mucous membrane color with an eye color chart to determine the severity of anemia, is used to decide whether an animal needs treatment (Kaplan *et al.,* 2004). This method has facilitated quick identification of *H. contortus* infected sheep and goats without the aid of any laboratory procedures and delivers the treatment only to those who require it (Vatta *et al.,* 2009; Kaplan *et al.,* 2004). Other strategies adopted to reduce risk of haemochosis include adequate nutrition to pregnant ewes and lambs including good quality protein and trace mineral/vitamins so as to naturally boost up immune mechanism

(Macarthur *et al.*, 2014). Superior nutrition also increases resilience in animals against infection.

In conclusion, gastrointestinal nematodiasis is ubiquitous with haemonchosis at the top of the list. These parasites lead to prolonged debility and emaciation in affected animals. Almost every farm animal gets infected with GIP once in their entire life period. Economic losses by these nematodes occur in varied form directly and indirectly affecting animal production status. Because of high pathogenicity various control measures have been adopted to combat the problem due to parasitism. These include various chemicals and non-chemical methods along with integrated pest management (IPM) programme which are of utmost importance. Nematode species are evolving and have developed resistance to various anthelmintics mainly of genera *Haemonchus*, *Ostertagia*, and *Trichostrongylus* therefore making them economically important.

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