

Review Article

Haemonchosis in Small Ruminants: A Review

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ABSTRACT:

The small ruminants have a great economic importance in the world. Sheep and goats play a central role in the socio economic importance well-being of people and value addition in the economy of country by providing benefits in terms of nutrition, extra income, intangible advantages (savings, insurance against emergencies, cultural and ceremonial purposes) and support survival to poor-resource farmers in Pakistan. Throughout the developing countries, sheep and goats put together an extremely valuable contribution, particularly to the poor people in the rural areas. These contributions are the production of animal proteins (milk and meat) draught power in the highlands, skins and fiber production and food security to the people. But these contributions of small ruminants are limited as compared to the consumption by the people. Research and developmental investments are in working and in process but these contributors do not meet the requirement of the people especially in rural areas in developing countries.

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HAEMONCHOSIS

Haemonchosis is the most economically important and deteriorating parasitic problem of

sheep and goats in Pakistan that is caused by *H. placei* and *H. contortus* (Qamar *et al.*, 2011).

H. contortus is a dominant, very much pathogenic and economically important gastro-

ntestinal nematode of sheep and goats (Husnain and Usmani, 2006). *H. contortus* is an important, voracious blood sucking parasite of small ruminants found in abomasum, cause major production losses world-wide and heavy burden of this blood feeding parasite causes anemia, diarrhoea, loss of weight, oedema, recumbency, severe debility and ultimately death (Nabi *et al.*, 2014; Squires *et al.*, 2011).

H. contortus is particularly an important abomasal nematode and causes substantial production losses at lower level of infection and in heavy infection it causes severe anemia and death of animals (Ejlertsen *et al.*, 2006). Each worm of *H. contortus* sucks about 0.05 mL of blood per day by ingestion or liberation from lesions (Qamar and Maqbool, 2012).

H. contortus is basically present in the abomasum of sheep and goats and it is commonly known as blood sucking twisted stomach parasite. Across the subtropics and tropics regions *H. contortus* is ranked as the most important worm of sheep and goats and causes dangerous draw off on production, loss of weight and even death in young animals as well as the emerging anthelmintic resistance. This parasite disease (*H. contortus*) is rampant wherever small ruminants are raised, but it produced major economic losses in tropical and temperate regions. The disease has also found in the colder climates and recently been found as far north as the Arctic Circle (Fentahun and Luke, 2012).

H. contortus has also effects on digestive efficiency and poor reproductive performance which can lead to loss of meat (27%) and wool (40%) among sheep and goats (Mushtaq *et al.*, 2011).

Prevalence and intensity of haemonchosis: There was heavy infestation of ecto and endo parasites and these parasites were spreading disease on the grazing land to both farmers and animals. The prevalence of *H. contortus* was 94.23% that was most prevalent

species in these parasites. The maximum occurrence of *H. contortus* was noted during august and there was a significant difference ($p < 0.05$) from the other months (Mbuh *et al.*, 2008).

In slaughtered sheep and goats the prevalence of *H. contortus* was determined at Multan abattoir. A total of 4740 animals were slaughtered and examined from 21 January 2007 to 20 February 2007 in Multan abattoir. In case of sheep, 793 out of 2133 were positive and prevalence of *H. contortus* infestation was 37.18% while 811 out of 2607 (31-10%) goats were positive. Sex wise prevalence of *H. contortus* in sheep was 34.11% (291/853) in male and 39.22% (502/1280) in female while in goats prevalence in male was 29.91% (312/1043) and in female was 31.90% (499/1564) (Raza *et al.*, 2009).

A research was conducted at Government farm that was Research Centre for Conservation of Sahiwal Cattle (RCCSC) Jehangirabad, District Khanewal from February 2007 to June 2007, to investigate the overall prevalence of *H. contortus* in sheep. The study revealed that *H. contortus* had an overall prevalence of (77.7%). The males showed significantly ($p < 0.05$) higher prevalence (84.6%) as compared to females (72.1%). Maximum prevalence (100%) was recorded in age group of 186-205 months and minimum (50%) in the age group of 146-1650 months showing the statistical significance ($p < 0.05$). Maximum prevalence (100%) was recorded in weight group of 72-78 and 79-85 kg, while weight group of 58-64 kg had minimum prevalence (50%) with statistical significantly ($p < 0.05$) different. In different breeds of sheep the prevalence was statistically significant ($P < 0.05$); Awassi was more susceptible showing higher prevalence (93.3%) followed by Lohi (85.9%) and Hisardale (74.4%) (Tasawar *et al.*, 2010). A recent Swedish survey was done and studied that in the northern near the Arctic Circle

most occurrence of *H. contortus* was discovered (Lindqvist *et al.*, 2001).

A study was done from August 2004 to December 2005 for the prevalence of various gastrointestinal parasites. A total of 338 fecal samples were taken (252 from goats, 86 from sheep) to find out the prevalence of different internal parasites in the region of twin cities of Islamabad and Rawalpindi. The prevalence of endoparasites was 65.7%. The prevalence of GIT parasites was higher ($p = 0.059$) in sheep 62 (72%) than in goats 160 (63.7%). The different endoparasites were identified in sheep that were *Fasciola* (4.38%), *Nematodirus* (29.03%), *Trichuris* (32.25%), *Coccidia* (51.61%), *Haemonchus* (80.64%) and in goats only *Coccidia* (57.5%), *Trichuris* (62.5%), *Haemonchus* (75%) were identified (Asif *et al.*, 2008).

The two most Important Gastrointestinal Nematodes (GIN) of sheep are *H. contortus* and *Trichostrongylus colubri-formis* are in temperate and tropical areas. A mainly temperature and moisture effect the development of free-living stages of these parasites. For the successful development to the third larva (L3) of parasites sufficient moisture and suitable temperature are needed. For the development of eggs to the third larva (L3) moisture available in the feces is more important for *H. contortus* than *Trichostrongylus colubriformis* because *H. contortus* has the egg shell of more permeable to water at all temperatures, making *H. contortus* more prone to desiccation (O'Connor *et al.*, 2006).

An experiment was carried that *H. contortus* third stage larvae (L3) were inoculated with 400, 1600 or 16000 to the 10 lambs of each of Hari, Najdi and Neimi breeds. The lambs developed sub-clinical forms of *Haemonchus* infection as they remained alert. The lambs were alert and developed sub-clinical form of infection of *Haemonchus*. The

lambs maintained PCV values within the normal range and a stable growth rate, quantity of eggs were tended to increase in all lambs relative to dose of infective larvae and there was no significant ($p > 0.5$) difference among three breeds of sheep (Fatani *et al.* 2006).

The seasonal trend of *H. contortus* was observed. In an experimental study from December 2004 to January 2006, the seasonal trend and the prevalence of *H. contortus* in goats and sheep were examined. The samples feces of 961 goats and 968 sheep of various breeds were taken and examined by the modified McMaster method. A significantly higher ($P < 0.05$) prevalence was observed in sheep as compared to goats. The highest infection was observed during rainy season (July-October) and lowest during December to May. Egg per gram count was highly observed in Islamabad then Attock, Jhelum and in last in Chakwal district in sheep. While, in goats the EPG count was present in Islamabad higher next Jhelum, Attock and at the end Chakwal district. A non-significant variation was examined between dissimilar breeds of sheep and goats at the same site and a significant ($p < 0.05$) variability in EPGs was noted from site to site among different breeds of sheep and goats, whereas Salt-Range (Latti) sheep and Hairy (Jattal) goats breeds had significantly decreased EPGs level along with higher level of Hemoglobin (Hb) and Packed Cell Volume (PCV) as compared to other breeds. The modified Mc Master method explained rectal fecal samples for Fecal Egg Counts (FECs) for nematode parasites and was processed at a sensitivity of 50 Eggs per Gram (EPG) of faeces. At 10 X magnification *H. contortus* (L3) larvae were examined and were recognized according to morphological characteristics and the keys that were by different scientist. The significant difference ($P < 0.05$) and intensity wise prevalence of *H. contortus* were examined at various sites in unlike

breeds of sheep. The maximum prevalence of infection was at Islamabad (3.08 ± 0.5) in Afghani sheep then was present in Afghani x Awassi cross (2.98 ± 0.3) in Attock and lowest in Awassi sheep (2.86 ± 0.2) in Jhelum district. There was constantly variation in fecal egg count regarding in different breeds at different sites. On the other hand in Latti sheep, Lowest Egg Counts (LFECs) were recorded first at Islamabad (2.89 ± 0.4) next was at Jhelum (2.39 ± 0.2) then Chakwal (2.16 ± 0.5) and Attock (2.58 ± 0.1). Moreover, at the same site various breeds of sheep had not significantly difference. There was no significant difference in mean LFECs in different breeds of goats, but level of infectivity (FEC) had significantly ($p < 0.05$) different among different breeds at various sites. The overall prevalence of *H. contortus* infection was in Beetal x Hairy cross at Islamabad (2.58 ± 0.1) with highest mean EPG count subsequently was Jhelum and Attock districts, whereas the lowest level of *H. contortus* infection was observed in Teddy goats at Chakwal district (1.53 ± 0.2). In the month-based occurrence of *H. contortus* there was significant difference among different places in sheep and goats all over the year. But, rate of *H. contortus* infection was higher in sheep ($p < 0.05$) than goats. However in clear trend of season there was fluctuation in the infection of *H. contortus* between sheep and goats species. (Chaudary *et al.*, 2007).

The occurrence of haemonchosis in sheep and goats was studied by the IHA and DID tests. The higher frequency of infection was in sheep (72.5%) than goats (56%) showed by the results. The age based prevalence in sheep was observed as 79.16% among 1 to 3 years of age while in case of goat the age wise prevalence was 70.3% in the similar age groups. In sheep the frequency of infection of *H. contortus* in mild, moderate and high form of infection was 16.7%, 70.8 and 12.5, respectively. But in goats the prevalence of mild (33.3%) and

moderate forms (66.7%) were documented. The highest prevalence of *H. contortus* was observed in July/August (47.7%) whereas least occurrence was examined in September/October (3.1%) according to seasonal pattern. The sensitivity of IHA, DID and fecal culture was recorded as 56, 47 and 42%, respectively. The specificity of DID and IHA it was 94.7 and 98.2% was recorded while as fecal culture was 89.5 % (Durrani *et al.*, 2007).

The seasonal prevalence of the egg, adult and the frequency of round worms of sheep and goats in January and December 2002 in the semi-arid zone of north-eastern Nigeria. 102 sheep and 147 goats were taken and observed by the modified McMaster method that was 44 (43.1%) and 82 (55.8%) of the samples respectively contained minimum one nematode parasite egg type (Nwosu *et al.*, 2007).

There was another experimental study concerning the prevalence of haemonchosis was observed as 38% out of 500 fecal samples of sheep at Jaba sheep Farm (Mansehra). Higher prevalence was recorded in sheep below one year than above one year. No significance difference was noted among males and females (Tariq *et al.*, 2003).

A fecal survey was conducted to find out the incidence of abdominal round worms infecting the sheep in an area with Atlantic type of climate where sheep raising was replacing cattle. From 49 sheep farms, 1710 fecal samples were haphazardly collected and were examined by using the flotation techniques during September 2001 to November 2002. The prevalence in sheep was 100% (Pedreira *et al.*, 2006).

There was an experimental study to compare the susceptibility of *H. contortus* infection in the Canaria sheep breed and the Canaria Hair Breed sheep in the Canary Islands. Sheep were out in the open with twenty thousand larvae of *H. contortus* infestation for experimental purpose and sheep were slaughtered on days 7 and 28 of post-infection.

There was no variation between breeds of sheep in juvenile parasites counts at days 7 or 28 of post-infection. Whereas in evaluation the Canaria Hair Breed sheep exposed lower adult worm counts, lower EPG counts, lower number of eggs in utero and female worm inhibiting than the Canaria sheep breed. Overall, that there was the greater resistance to *H. contortus* infection in the Canaria Hair Breed sheep than Canaria sheep (Gonzalez *et al.*, 2008).

For diagnosis of *H. contortus*, parasitological, hematological techniques were applied by various researchers. Fecal samples were collected from all sheep by hand in suitable containers in 10% formalin solution and very cautiously tagged with animal I.D, sex, age and month of collected works. Samples were primed for identification of *H. contortus* eggs in saturated NaCl solution. Eggs Per Gram (EPG) of fecal sample were counted to estimate the worm burden using McMaster technique. The McMaster technique was applied for counting the number of nematode eggs per gram (EPG) in feces by suspending the fecal material in a saturated salt solution. Two grams of each fecal sample was weighed out with the help of digital electronic balance (AY 220, Shimadzu Corporation, Japan) and placed in a plastic beaker (250 mL). The fecal pellets were mashed fully with the help of mortar. About 30 mL of water was added into the beaker and mixed well along with the feces. The fecal sample was then homogenized for one minute with the help of homogenizer. One mL of sugar solution was placed in the test tube with the help of pipette and added 1ml of fecal sample to the test tube with the same pipette. Then the solution was mixed thoroughly. The fecal material passed through sieve to remove debris prior to pouring in McMaster chambers. The prepared samples were taken up with pipette and dispensed into both chambers of the McMaster counting slide (each slide comprising two chambers each of 10x10 mm; the space between object-glass and cover slip was 1.5 mm and each

compartment contains of 0.15ml). The number of the eggs (ova) of *H. contortus* within the both grid of the chamber was counted, using microscope (OSK, Japan) with magnification power of 10X and 40 X. The number of eggs in per gram of a fecal sample were obtained by the number (X) of eggs found multiplied with 60/2 and 1/0.15 or X200 (Tasawar *et al.*, 2010).

There is diagnosis of *H. contortus* through hemogram, for the determination of PCV and Hb levels blood samples were taken from the jugular vein in EDTA coated vacutainer tubes (Coffin, 1995).

H. contortus eggs contained eggshells that changed in membrane environment by fluidity measurements during the embryonation and their effects on non-specific methods of conflict to anthelmintics were observed (Riou *et al.*, 2005).

Hematological and biochemical effects of haemonchosis: *H. contortus* cause hematological and biochemical disturbances and produced adverse effects in sheep and goats by drop off the normal values especially in erythrocytes, lymphocytes, hemoglobin, packed cell volume (Ijaz *et al.*, 2009).

H. contortus has serious effect on serum biochemistry and enzymatic assays particularly change in the levels of acidic phosphate (ACP), alkaline phosphate (ALP), aspartate aminotransferase (AST) or serum glutamate oxalate transaminase (SGOT) and alanine aminotransferase (ALT) or serum glutamate pyruvate transaminase (SGPT) were reported to be increased significantly in grazing sheep and goats (Hassan *et al.*, 2013).

The effect of eosinophilia during helminthic infection and interaction between eosinophil's and parasites were studied in an experimental study. Several galectin-like proteins were also produced from *H. contortus* larvae and minimum one of which revealed eosinophil chemo-kinetic activity in vitro (Turner *et al.*, 2008).

There is a change in Total Serum Protein (TSP) level in sheep and goats, synthesis of proteins in liver was found to be increased and was suggested to be due to the loss of plasma protein into the intestine as a result of increased mucosal permeability caused by *H. contortus* and many more parasites (Bahrami *et al.*, 2011).

Haemonchosis has different dangerous effect on body include edemas, reduction of plasma proteins, changes in Gastric glands, the presence of serum pepsinogen, gastrin and increased number of circulating eosinophils are noticed in peripheral blood. The final stages of the disease may be accompanied by emaciation and death may result (Tehrani *et al.*, 2012).

The effects of age on hematological changes and clinical observations of *H. contortus* was examined experimentally in West African Dwarf (WAD) goats. 10 kid goats and 10 apparently healthy adults were infected orally as experimentally for a period of 5 weeks with 750 infective larvae of *H. contortus*. From kids and adult animals the fecal samples and blood were collected before and after infection and animal weighted also. By the use of t-test statistical analysis was done. The effect of age was non-significant on clinical observations on the infected WAD kids and adults. Respiratory rate, rectal temperature, heart rate were normal but there were anorexia, , intestinal distension, muscular weakness by worms and there were loss of weight, reduced feed intake, diarrhea reduced carcass quality and anaemia. The anaemia was normocytic-nomochromic anaemia in characterization. The age had significantly difference $p < 0.05$ on weight loss and erythrocytic values as compared with the control group. On erythrocytic indices, differential leucocyte counts and the total WBC the age effect of was not significantly different at $p > 0.05$. There are directly proportional relation to the level of helminthes eggs on erythrocytic values and weight in the faeces (Ameen *et al.*, 2010).

Anaemia is not a disease entity but commonly seen as a result of generalized disease process. This term is defined as an absolute decrease in Red Blood Cell (RBC), hemoglobin concentration below the normal values (HB) and decrease in the packed cell volume (PCV). Haemonchosis is an important disease of sheep, goats and cattle in Africa leading to high mortality and high morbidity in lambs and kids. Considerable damage is caused by fourth-stage larvae (L4) of abomasal parasites leading to reduced appetite, haematological changes and reduced digestive capability of the abomasum. Furthermore explained that there are various types and classification of anaemia due to pathophysiology, morphology and bone marrow response that affect livestock leading to undesirable clinical signs. These changes may result in mediated haemolytic anaemia, metabolic disease, depression or hypoproliferative, anaemia associated with organ or tissue disorders, Aplastic or hypoplastic anaemia, myeloproliferative disorder and anaemia associated with parasitic disease haemorrhagic and haemolytic anaemia the most common ones which affect (WAD) goats in this environment, leading to high mortality and high morbidity (Ameen *et al.*, 2006).

In an experimental study it was examined the level of serum albumin was significantly different ($p < 0.05$) by providing good protein nutrition. There was also significant ($p < 0.05$) difference in the level of serum globulin that otherwise would be low in haemonchosis. However, enhancement in the dietary protein level appeared had no effect on and total serum protein level and the packed cell volume (Nnadi *et al.*, 2007).

The mean abomasal pH (5.2 ± 0.6) was significantly different ($p < 0.05$) in infected animals corresponding to animals of control groups (3.23 ± 0.4). ESR and Plasma pepsinogen were significantly different ($p < 0.05$) whereas reduction in values of RBC, PCV, total serum proteins and Hb were observed in infected animals compared to control group (Mir *et al.*, 2007).

For the diagnosis of *H. contortus*, ELISA was a useful technique which is economically important and one of the most pathogenic parasites of sheep and for *H. contortus* ELISA was 53.6% sensitive (Xiaojun *et al.*, 2007).

The diagnosed *H. contortus* by ELISA using adult crude somatic and excretory-secretory antigens of *H. contortus*. The diagnostic sensitivity of ELISA using excretory secretory antigens was 87.5%, which was significantly higher compared to crude somatic antigen 72.22%. Mean ELISA absorbance value of excretory-secretory antigens was significantly higher corresponding to crude somatic antigens. Excretory secretory antigens showed 92.02% specificity compared to 76.81% of crude somatic antigens ($p < 0.05$). The results revealed that excretory secretory antigens are very sensitive and may be useful as a supplementary method for diagnosis of haemonchosis in ruminants (Mir *et al.* 2008).

Treatment and control of haemonchosis:

Haemonchosis is an important disease in cattle, sheep and goats all over the world. The mortality and morbidity rates were considerably cause by severe infection of *H. contortus*; even more, in adults it cause different degrees of anaemia and in lambs there may be body weight reduction by moderate infections. Control depends on continual application of anthelmintics (Nayebzadeh *et al.*, 2005). The treatment of haemonchosis is based upon anthelmintic drugs throughout the world. Chemicals are mostly used for the treatment and control of gastrointestinal parasites throughout the world. A trial was conducted by using of oral ivermectin, a mixture of levamisole injectable levamisole, niclosamide, albendazole sulphoxide and oral albendazole with the dose suggested by the producer. *Haemonchus* and *Trichostrongylus* infections were very effectively get rid of by these drugs (Arece *et al.*, 2004).

By orally use of levamisole at a dose rate of 7.5 mg kg⁻¹, oxfendazole at a dose rate of 4.7 mg kg⁻¹ or an oxfendazole/levamisole mixture at a dose rate of 4.6 mg kg⁻¹ the infection of *H. contortus* and *Ostertagia circumcincta* in sheep was treated. The presence and examination of the arrested larval burden in the abomasum of each sheep were evaluated the efficacies of the treatments at 12 or 13 days (levamisole) and 10 or 11 days (oxfendazole and oxfendazole/levamisole mixture) after treatment. The protection level of levamisole or the oxfendazole/levamisole mixture by a single dose was >99% against the arrested stages of both *H. contortus* and *Ostertagia circumcincta* as compared to control group (Andrew, 2000). Many control strategies have been incorporated to try and increase the efficacy of synthetic anthelmintics. Strategies such as the simultaneous use of many anthelmintic classes have shown to be synergistic and additive but the long-term use is open to discussion (Krecek and Waller, 2006). The use of many chemical produced resistance in the body of worms (Kaplan, 2004). The use of herbal medicine with the anthelmintic drugs has been studied. To curement the diseases of man and animals from ancient times many plants have been used. This treatment system is generally referred as 'folk, unani, indigenous or eastern' medicine.

The anti-cestodal properties of Kamila have been reported in the British Veterinary Codex (1953) and the British Pharmaceutical Codex (1934) for man and dog (Akhtar and Ahmad, 1992). For the treatment of various parasitic infections in man and animals the fruit of *Mallotus philippinensis* usually known as kamila has been commonly used in traditional medicine system. The plant of kamila has also other properties in folk medicine system that includes as cathartic, aphrodisiac, anthelmintic, styptic, styptic and it has also effects against tape

worms infections, eye problems, parasitic skin infections, systemically for urinary problems (Akhtar *et al.*, 2000; Deeba *et al.* 2009; Sharma and Varma, 2011; Ahmed and Siddiqua, 2013).

The treatment of haemonchosis is based upon anthelmintic drugs throughout the world. Chemicals are mostly used for the treatment and control of gastrointestinal parasites throughout the world (Ancheta *et al.*, 2004). But the use of these many chemical produced resistance in the body of worms (Mortensen *et al.*, 2003; Kaplan, 2004).

Mostly the plains areas of India and Pakistan have growth of many annual herb weeds like *Fumaria indica* commonly known as (Hauskn or Shahtrah) also known as "Fumitory". The *Fumaria indica* has many medicinal properties in folk medicine as an anthelmintic, diaphoretic, diuretic, cholagogue, laxative, sedatives and stomachic activities and it is also for cure of liver obstruction and purification of blood in folk medicine system (Gupta *et al.*, 2012). About 80% of the population depends on folk medicine system in developing countries for their basic health care needs by the estimation of World Health Organization (WHO) and most of the rural small-holder farmers cannot afford the cost of modern drugs (Nabukenya *et al.*, 2014).

On *H. contortus* eggs and larvae the ethanol extracts of *Azadirachta indica* was tested. The extracts were evaluated at five concentrations: 0.19, 0.78, 3.12, 12.5 and 50.0 mg mL⁻¹. Egg hatching ability of ethyl acetate extract at 50 mg mL⁻¹ was 51.31% and the larval development was 68.10%. The ethanol extract had more efficiency on the larval development that was 87.11% at 50 mg mL⁻¹ and egg hatching was restrained by 99.77% at 3.12 mg mL⁻¹. These results recommend *A. indica* extracts may be helpful in the control of gastrointestinal parasites of sheep and goats (Costa *et al.*, 2008).

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