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Control of *Haemonchus contortus* and its Challenge in Sheep and Goat - Review

[1]Tadesse Degu and [2]Haben Fesseha

[1]College of Veterinary Science, Mekelle University, P.O. Box: 2084, Mekelle, Ethiopia
[2]School of Veterinary Medicine, Wolaita Sodo University, P.O. Box: 138, Wolaita Sodo, Ethiopia

Abstract: In sheep and goat health management programs, control of internal parasites is a primary concern and is critical to profitability. *Haemonchus contortus* is a highly pathogenic blood-sucking parasite. Haemonchus can be diagnosed based upon the characteristic clinical sign of anemia, submandibular edema, weight loss and ill thrift along with finding large numbers of eggs in the feces. It causes a great loss in sheep and goat farms. To prevent this problem the owner or farmer and veterinarian should work effectively. They should be prevented pasture contamination on larval stage in early spring via timely and planned treatment strategies, rotate different doses of drugs on an animal basis, avoid underdosing anthelmintics, utilize safe pasture treatment and move schemes.

Key words: Sheep · Goat · *Haemonchus contortus* · Anemia · Submandibular Edema

INTRODUCTION

There are a lot of diseases of shoat, but none of them are found everywhere as or present as direct a threat to shoat as internal parasites. In sheep and goat health management programs, control of internal parasites is a primary concern and is critical to profitability. Gastrointestinal nematodes (GIN) that infect sheep and goats include *Haemonchus contortus, Trichostrongylus colubriformis, T. axei, Teladorsagia (Ostertagia) circumcincta, Cooperia* spp., *Oesophagostomum, Trichuris ovis, Strongyloides papillosus* and *Bunostomum.* These parasites can contribute to the overall problem of gastrointestinal parasitism of ruminants. Barber's pole worm which is also called *Haemonchus contortus* by its scientific name and is a highly pathogenic blood-sucking parasite which is the most prevalent and important in most regions of the US, especially in the southern [1].

Barber's pole worm is singly the most important of all the gastrointestinal nematodes that affect the survival and productivity of shoat owned by rural poor farmers in the developing world. This hematophagous parasite is infamous throughout the humid tropics subtropics, which is responsible for acute disease outbreaks with high levels of mortalities, particularly in young animals [1, 2]. It is economically important parasites in India about 103 million US$ was spent. *H.contorus* is a prominent parasite amongst the reports of anthelmintic resistance that has emerged in all countries of the world that produce small ruminants. This emergence of multiple anthelmintic resistance has provided a spur for research on alternative forms of control. Recent surveys in developing countries have identified many plants that are intended and have the potential to be used as anthelmintics against this parasite [2].

Haemonchosis can be diagnosed based upon the characteristic clinical signs of anemia, submandibular edema, weight loss and ill thrift along with finding large numbers of eggs in the feces. Female *Haemonchus* produce approximately 5, 000 eggs per day and caprine can be infected with thousands of these worms and these results in tens to hundreds of thousands of eggs being shed on to pasture by each animal each day. Because the life cycle is so short (< 3 weeks), this cycle of infection pasture contamination, reinfection and more pasture contamination can rapidly transform pastures into very dangerous places for goats. This is especially true in a warm environment such as Georgia because transmission of *H. contortus* occurs virtually year-round [3, 4].

Like other forms of most parasitic diseases, hemonchosis is most severe in young animals during their first year on pasture. However, since immunity to GI nematodes in goats is slow to develop and is incomplete,

Corresponding Author: Tadesse Degu, College of Veterinary Science, Mekelle University, P.O. Box: 2084, Mekelle, Ethiopia.

even mature goats are at considerable risk. There are several factors such as poor nutrition, concurrent disease, stress, overstocking, or pregnancy/lactation can cause a loss of immunity to parasites. It is well established that ewes and does lose much of their protective immunity to GIN around the time of kidding/ lambing causing the number of parasites infecting the does to increase. Subsequently, parasite egg production and contamination of the environment with infective larvae increases, creating a dangerous situation for the highly susceptible young kids. This phenomenon, known as the periparturient rise (PPR) is an extremely important part of the epidemiology of *Haemonchus* and must be considered when designing control programs [1, 5, 6]. This review aims to indicate the possible controlling methods used for *Hemonchus contortus*.

Overview on *Haemonchus contortus*

Etiology: The majority of gastrointestinal strongyles of ruminants belong to the family Trichostrongylidae. The genus *Haemonchus* is in the subfamily of Haemonchinae and consists of four main species in domestic ruminants, namely, *H. contortus (*in ovine and caprine), *H.placei* and *H. similis* (in bovine) and *H.longistipes* (in dromedary). *Haemonchus contortus* is a cylindrical gastrointestinal nematode commonly known as the red stomach worm, the wire-worm, or the Barber pole worm [7]. Adult worms are found in the abomasums of goats and sheep [8]. *Haemonchosis* caused by *Haemonchus contortus* is a predominant, highly pathogenic and economically important disease of sheep and goats [9]. These parasites are common blood feeders that caused anemia and reduced productivity and can lead to death in heavily infected animals [10].

Phylum	Nematoda
Class	Secernentea
Order	Strongylida
Family	Trichostrongylidae
Genus	*Haemonchus*
Species	*Haemonchus contortus*

According to Maphosa *et al.* [11], *H. contortus* is a highly pathogenic parasite of small ruminants, capable of causing acute disease and high mortality in all classes of stock affected. These parasites produce large numbers of eggs per parasite per day; this together with suitable climates of high temperature and rainfall ensures year-round, undisrupted development of larvae. *H.contortus* infection is so significantly high and of importance that it made the top ten list of the most common pathogenic nematodes of sheep and goats in the tropics and together with other nematodes and the second most common gastrointestinal infection that results in the death of sheep in Malaysia [12]. Gastrointestinal nematode infection ranks highest on a global index, with *H. contortus* being of overwhelming importance [11].

Morphology: An adult *H. contortus* measures about 15 to 30 mm long where the male is shorter than the female. The morphological characteristic of *H. contortus* is a mouth capsule with a single dorsal lancet and two prominent cervical papillae in the oesophageal area. The male parasite is characterized by its copulatory bursa formed of two large lateral lobes and a small asymmetrically positioned dorsal lobe [13, 14]. Together with the two chitinous spicules, which are inserted in the female genital opening during copulation, this part of the worm is important for identification. Females parasites have a reddish digestive tube filled with ingested blood, spirally surrounded by two white genital cords (ovaries). Eggs of strongyle type with a diameter ranging between 70-85mm [15- 17].

Predisposing Factors: One study which was conducted in HU indicates that important parasites of sheep and goats were identified and those factors affecting the epidemiology of these parasites of small ruminants in eastern Ethiopia were elucidated. Those parasites are includes that *Haemonchus, Trichostronglus, Nematodirus, Oesophagostomum, Fasciola* and *Paramphistomum* species were common helminths of sheep and goats in this part of Ethiopia [18].

According to the researcher from these GIT parasites, *H. contortus* is the most prevalent, representing more than 60% of the total worm burdens recorded in tracer tests. Sheep and goats were examined at the abattoir, where *H. contortus* worm counts exceeded 4000 during peak time. High levels of prevalence, intensity and abundance of these parasites were generally observed around the middle of the two rain seasons, with peaks occurring in May and September of the year. This confirmed that the weather conditions of the wet seasons were generally favorable for the development, survival and transmission of the free-living stages of nematodes [19].

Barbers pole worm is species most commonly encountered in small ruminants. The disease caused by this parasitic worm is hemonchosis, which is the most frequently observed gastrointestinal problem in tropical and sub-tropical regions of the world. Like any other the parasitic diseases it is in a dynamic interaction with its environment and the host, the outcome of which depends on various intrinsic and extrinsic factors [20].

Intrinsic Factors: *H.contortus* is a highly prolific, blood-feeding parasite with various strategies to escape adverse climatic conditions and immune reactions of the host. its ability to produce a large number of eggs during its lifetime provides *H. contortus* with an advantage over other parasites in that it can easily contaminate grazing areas and may survive in its small ruminant hosts through frequent and rapid re-infections [16, 17]. Variations in the degree of infectivity of different *H.contortus* isolates have been documented. A comparison in infectivity between *H. contortus* isolates from France with those from West Indies (Guadeloupe) in two breeds of sheep, namely the Black Belly and the INRA 401, has shown that the latter established between than the former in the Black Belly suggesting that it is important to take into account parasite genetic diversity in different agroecological zones [21].

Extrinsic Factors

The Environment

Climate and Vegetation: Factors including temperature, rainfall, humidity and vegetation cover influence patterns of parasite development [22]. in most tropical and sub-tropical countries, environmental temperatures are permanently favorable for larval development. the ideal temperature for larval development of many nematode species in the microclimate of the pasture or vegetation is between 22 and 26°C while the best humidity is close to 100% [23].

Desiccation from lack of rainfall kills eggs and larvae rapidly and is the most lethal of all climatic factors. A pasture larval assessment in Ghana and the use of tracer lambs in Kenya revealed that very few or no *H. contortus* infective larvae were available during dry periods while numbers of larvae were high in the rainy seasons and shortly after [24]. Below 5°C, movement and metabolism of L3 larvae are minimal favoring prolonged survival as these larvae are enclosed in a double sheath and thus unable to feed to continuously renew their energy [25].

Nutrition: There is substantial evidence for a beneficial role of a good plane of nutrition in the resistance or resilience of sheep to GI nematode infections [26]. Nutrition can influence the development and consequences of parasitism in three different ways: (1) it can increase the ability of the host to cope with the adverse consequences of parasitism (resilience), (2) it can improve the ability of the host to contain and eventually to overcome parasitism (resistance) by limiting the establishment, development and fecundity of the parasitism and/or (3) it can directly affect the parasite population through affecting the intake of certain antiparasitic drugs. Highly metabolizable protein diets have been shown to augment resistance of Ile de France and Santa Ines lambs against *H. contortus*. Well-fed animals can withstand the harmful effects of GI parasitism and remain reasonably productive and may require less antihelminthic treatments when compared with undernourished animals [27]. The major problem in this respect is that hemonchosis is more prevalent in regions where the animal feed resources are very scarce and/or improperly managed and therefore insufficient to satisfy the demand throughout the year [17, 18].

Nature of the Host

Host Breed: Though it is still not clear how natural selection might shape patterns of immune responsiveness in terms of type and strength of the response, different breeds of sheep express different susceptibility to gastrointestinal parasitic infections. In this respect, the Santa Ines [28], Barbados Black Belly and Texel [29]. breeds of sheep are known to be more resistant to infection with *H. contortus* compared with Suffolk and Ile de France, INRA 401 and Suffolk breeds respectively [15]. This is evidenced by reductions in fecal egg count (FEC) and/or worm number, slower worm development and reduced fecundity. Genetic variations in the resistance to *H. contortus* within sheep flocks have also been demonstrated and used in breeding schemes in Australia [30].

Age, Sex and Reproductive Status of the Host: In addition to genetic factors, animals of different ages and sex respond differently to parasitic infections under similar management conditions [15]. Young animals are generally more susceptible to parasitic diseases than adults [31]. It is believed that lower resistance to disease in young ruminants is partly due to immunological hyporesponsiveness and is not simply a consequence of their not having been exposed sufficiently to pathogens to develop immunity. Innate immunity, often age-related, is also considered important in many cases. This may be due to Physico-chemical differences in the gut environment in adults compared with young hosts [32].

On the other hand, previous exposure to *H. contortus* infection could result in enhanced resistance to subsequent infections [33]. Improved resistance to *H.contortus* was reported in second infections in Rhon and Merino land and Black Belly and INRA 401 lambs [34]. this may be due to the alteration of immunological and physicochemical mechanisms that while incapable of controlling the primary infection is nevertheless able to influence the challenge infections [21].

In a recent study, it was reported that male lambs excreted significantly higher number of fecal eggs, carried a higher number of *H. contortus* worms and were more anemic than their female counterparts [35]. Earlier studies with *H. contortus* showed that castration enhanced the resistance of male lambs to the extent that FEC was lower than those of female lambs suggesting the existence of hormone-related influences [36]. The phenomenon of the peri - Parturient rise (PPR) in nematode egg output is also of great importance in the epidemiology of GIT nematodes of sheep. This is due to a temporary loss of acquired immunity to infection at around the time of parturition and during lactation and the PPR in FEC started 2 to 4 weeks before lambing and continued into lactation in the post - parturition period [37].

Pathogenesis: Haemonchosis in sheep may be classified as hyperacute, acute, or chronic. In the hyperacute form, death may occur within one week of heavy infection without significant signs. This form of the disease is very rare and appears only in highly susceptible lambs. The acute form is characterized by severe anemia accompanied by edema bottle jaw [3]. Anemia is also characteristic of the chronic infection, often of low worm burdens and is accompanied by progressive weight loss [25].

The chronic form is the most commonly observed during natural infections. The lesions are associated with anemia resulting from blood loss. *H. contortus* is known to produce calcium and a clotting factor binding substance known as calreticulin enabling the parasite to feed easily on host blood and in so doing cause hemorrhagic lesions [38].

Life Cycle of *Haemonchus contortus*: *Haemonchus contortus* is a blood-sucking gastrointestinal nematode parasite belonging to the family Trichostrongylidae. The typical life cycle begins when the adult female lays eggs that are passed out in the feces of the animal. Hatching of the eggs is controlled by temperature and humidity and also to an extent by the larva within the egg [39]. Eggs are passed out in the feces of the mammalian host. The eggs hatch and develop into the L1 and L2 juvenile stages in the feces while feeding on bacteria. The L1 stage usually takes about 4-6 days to develop under temperatures in the range of 24-29°C [17].

The L2 stage then develops into the L3 stage, which is referred to as the filiari-form infective larvae, by shedding its cuticle. The L3 stage remains in its cuticle and crawls up the grass blades awaiting ingestion by a final host (the herbivore), which becomes infected post-ingestion. This larva settles in the abomasum where it sheds its cuticle and burrows into the abomasum layer where it develops into the adult stage L4 [40]. This larva in turn sheds its cuticle and develops into the adult stage (L5). Male and female worms mate and live in the abomasum where they feed on the blood of the host. The life cycle reported here is extracted from Hale [7].

An important phenomenon observed in the life cycle that has epidemiological implications is arrested larval development or hypobiosis. Hypobiosis is the temporary cessation of development of a nematode at a particular point in its parasitic development. Hypobiosis usually follows the onset of cold autumn/winter conditions in the northern hemisphere or very dry conditions in the subtropics and tropics [39]. It is usually due to an unfavorable environmental stimulus, such as cold weather or dry conditions received by the free-living L3 before ingestion and usually coincides with the onset of winter or very dry conditions. Arrested development can occur in the gut of sheep or on pasture and ensures the survival of the nematode under adverse climatic conditions. Subsequent maturation of the larvae due to resumption of development known as the 'Spring rise', when favorable conditions return in the spring, leads to a rapid rise in infection levels or fecal egg counts in the sheep [41].

Clinical Signs: The clinical signs, mainly anemia, edema and loss of weight in association with reduced hematocrit values might be characteristic of hemonchosis in sheep [25]. At *Post mortem,* the abomasum appears oedematous with petechial hemorrhages, occasional nodular developments and a rise in pH. Feces are well-formed; diarrhea occurring only in infections complicated by the presence of such species as *Trichostrongylus* species and *Cooperia* species. Labs are the most seriously affected members of the flock, but older sheep under stress also may have fatal anemia A heavy *Haemonchus* species infection (20, 000 - 30, 000 worms) can kill a sheep very quickly [42].

Diagnostic Methods

General Signs: *Haemonchus contortus* infection is clinically diagnosed by anemia, dehydration, submandibular internal fluid accumulation that results in the formation of a bottleneck, diarrhea and low packed-cell volume (PCV). Infection also results in retarded growth; weakness reduced reproductive performance, general illness and death [8].

Microscopical Techniques: Haemonchus eggs were identified based on morphology [43]. Species whose eggs exhibit similar morphological characters and therefore cannot be distinguished from each other can further be subjected to larval culture and identification of the third stage larvae (L3) [44]. Supplementary diagnosis is achieved through the use of microscopic techniques by the recovery of *H. contortus* eggs from stool samples. Because the eggs of many important genera are morphologically similar and therefore hard to identify to species level, a better way of delineating species is by larval culture and identification of 3rd stage larvae [40].

Demonstration of parasite eggs in fecal material can prove the presence of infection and is the most commonly used diagnostic method. Nevertheless, this method does not always reveal the presence of the parasite during the low levels of parasitic burden and pre-patent periods requiring repeated examinations. Host resistance to GIT helminths also delays egg-laying and a change in female worm size affects its fecundity. Hence, egg counts do not necessarily reflect the number of worms present. Other methods like measurement of parasite-specific antibodies can be used as supplementary diagnostic tools [45].

Serological Techniques: The alternative diagnosis is based on serological techniques including ELISA [46]. According to Thekisoe *et al.* [47] the biggest drawback of tests that rely on the detection of antibodies is their inability to distinguish between past and present infections. Molecular techniques have proved more rapid and accurate than both microscopy and serology hence there has been a recent movement towards the development of molecular assays for the detection of helminth infections [47, 48].

Polymerase Chain Reaction: Polymerase chain reaction (PCR) was first developed in the 1980's by Kary B. Mullis [49]. PCR for detecting trichostrongyle infections, including *H. contortus,* in ruminants, was developed by Von Samson-Himmelstjerna *et al.*[44]. The assay consisted of four genus-specific primer/probe sets enabling sensitive and specific amplification of target DNA from four trichostrongyle genera in the presence of multiple infections. Several other successful PCR- based assays have been developed over the past decade for identification and differentiation of strongyle infections. However, PCR assays are more expensive as they include the use of expensive probes and cheaper methods of diagnosis are a necessity, justifying the need to develop a PCR assay for detection of *H. contortus* infections as a supplementary diagnostic tool [50].

Worm Count and Identification: According to Zajac *et al.* [51], Haemonchus can be recovered from each of the infected abomasum in slaughterhouses is possible to count and morphologically identify [51, 52].

Treatment: One of the challenges of *Haemonchus contortus* in shoat is killing the animals in a short time in acute cases and other economical losses in chronic conditions. At this time, the affected animal should be treated with Albendazole 5 mg/kg, Fenbendazole 5mgkg, oxfendazole 5mgkg, levamisole 7.5mg/kg, Ivermectin 0.2 mg/kg, Moxidectin 0.2 mg/kg and Closantel 10 mg/kg [39, 52].

Control of Haemonchosis and its Challenges: The objective of most parasite control method is not to completely avoid the parasites in livestock, but to keep the population under a threshold, above which it would otherwise inflict harmful effects on the host population. Any parasite control method aimed at minimizing a given parasitic population must consider the basic disease determinants briefly described above. the relative success or failure of any control strategies can be judged in terms of immediate and long term objectives, the ultimate goal being increase production, minimizing risks regarding drug resistance and consumer and environment associated problems. Generally, nematode control strategies can be directed against the parasite in the host and the environment [53].

Targeting the Parasite in the Host

Chemoprophylaxis: Anthelmintic drugs are commonly used either for prophylactic purposes, in which the timing of infections or clinical outbreaks [25]. Since, the advent of modern anthelmintics, enormous advances have been made to make use of various preparations for different species of animals against a diverse spectrum of parasites. the relative success of these drugs depending on their ease of administration, the persistence of action after administration and frequency of application based on the epidemiology of the disease problem. In most cases, anthelmintics are administered per os in the form of a solution, paste, or bolus but there are some, which can be given via other (parenteral, etc.). In temperate areas priority is usually given to strategic treatment rather than to a regular interval dosing with anthelmintics. Animals at risk, such as wind lambs, are often treated during the first grazing season. Strategic deworming is very important especially in some arid areas where hemonchosis is a problem, during rainy season animals should be treated twice, four weeks after the onset of the rains and at the end of the rains [17, 25, 26].

Additional treatment at the culmination of the wet season may sometimes be necessary. Various drugs are successful (almost 100%) in eliminating *H. contortus* during their early periods of utilization and some still remain effective in different parts of the word (Table 1). Hence, in the traditional sense of chemotherapy - chemoprophylaxis, we have probably achieved the maximum effect of what is possible from excellent anthelmintics developed by the pharmaceutical industry since 1960, i.e. from thiabendazole through levamisole and morantel tartrate, to more advanced benzimidazoles and the avermectins and milbemycins [3].

Table 1: List of some recommended drugs against *Haemonchus* in sheep

Chemical group	Anthelmintics	Prescribed dose
Imidazothiazoles	Levamisole	7.5mgkg
Benzimidazole	Albendazole 5mgkg	5mg/kg
	Fenbendazole 5mgkg	5mg/kg
	Oxfendazole 5mgkg	5mg/kg
Macrocyclic	Ivermectin	0.2mg/kg
Lactones (avermectins)	Moxidectin	0.2mg/kg
Salicylanilides	Closantel	10mg/kg

Source: [39]

For various reasons, the efficacy of such valuable and very effective drugs is endangered. Their long - term utilization, inappropriate handling and under-dosage may be among the reasons for their reduced efficacy and the increasing development of drug resistance. On the other hand, where these drugs are not easily accessible because of either economic reasons or scarcity of veterinary services, as in most parts of Africa, animals die as a result of acute hemonchosis or develop a chronic form of the disease resulting in a marked loss of body weight and consequently reduced production. This adds another constraint to the already existing poor production performance of small ruminants in such regions [4].

Risk of Drug Resistance: Development of drug resistance by populations of *H. contortus* in sheep and goats to repeated applications of benzimidazoles, levamisole and ivermectin has already been demonstrated (Table 2). in most cases were resistance against various anthelmintics has been reported, *closantel* remained as the only efficient drug available signaling the urgent need to develop alternative measures. *H. contortus* strains resistant to one group of drugs may also be resistant to other groups of drugs, which suggest the existence of multiple resistances to the major anthelmintic drugs currently available. In one experimental study, Waruiru [54] tested the efficacy of *Closantel, Albendazole, Levamisole* and *Ivermectin* against *Ivermectin* resistant and susceptible isolates of *H. contortus* in sheep.

A very impressive result was obtained where all these drugs were almost 100% effective against *Ivermectin* susceptible isolates while the only *closantel* proved efficacious on the *ivermectin* resistant strain. Further alarming findings were also reported where such resistance in *H. contortus* was found to be inherited as either dominant or recessive traits. According to Le Jambre *et al.* [55], a completely dominant autosomal trait governs the resistance of *H.contortus* resistance was sex influenced [55].

On the other hand, resistance to *Levamisole* and *Benzimidazoles* has been reported to be inherited as an incomplete recessive autosomal trait. Highly prolific species such as *H.contortus* with a relatively short life expectancy of adult worms have a higher risk of developing diverse resistance- alleles due to spontaneous mutations than the less prolific *T. colubriformis* [56].

Table 2: Some examples of drugs to which resistant strains of *H.conturtus*

Continent	Country	Anthelmintics	Reference
Africa	Ethiopia	Albendazole, Tetramizole	[57]
	South Africa	and Ivermectin	[58]
Europe	France	Benzimidazoles,	[59]
	G. Britain	Levamisole Benzimidazoles	[60]
Asia	Malaysia	Benzimidazoles, Levamisole, Closantel, Ivermectin	[61]
South America	Argentina	Benzimidazoles,	[62]
	Uruguay	Levamisole, Closantel, Ivermectin Benzimidazoles, Levamisole, Ivermectin	[63]
Australia	Australia	Benzimidazoles, Levamisole, Ivermectin	[55]

Therefore, if effective parasitic treatment with the existing drugs is to continue, more efficient and strategic dosing regimens must be practiced to enhance the efficacy or prolong the useful lives of the currently available anthelmintic compounds. Reduction of feed intake before oral anthelmintic treatment slows ruminant digesta flow and premature drug removal [64, 65].

Improved drug delivery systems such as the use of chemicals or physical carriers (salts, oils, etc) that reduce drug absorption and metabolism and that can specifically direct large quantities of actives to the sites of parasite habitat must be adopted, but these should be cost-effective [66].

Copper Oxide Wire Particles: Copper oxide wire particles (COWP) are another control method being used against *Haemonchus contortus* infections in sheep and goats. The American Consortium for Small Ruminant Parasite Control (ACSRPC) began to examine the use and safety of copper oxide wire particles (COWP) as an anthelmintic for sheep and goats in 2003 due to the universal prevalence of anthelmintic resistance. COWP is available commercially to alleviate copper deficiency in ruminant livestock. COWP can be included in an integrated gastrointestinal nematode (GIN) control program, specifically to control *Haemonchus contortus* [67].

The bioavailability of copper in the gastrointestinal tract is sensitive to pH. Besides, copper from COWP in the abomasum was insoluble at pH greater than 3.4, which often occurs in GIN infects lambs (pH of uninfected lambs was less than 1). It was though that COWP could be indirectly acting on adult nematodes through the increased copper status of the host, or directly due to increased copper in the abomasum, which could potentially penetrate the cuticle of *H. contortus* [68].

Briefly, the administration of 2.5 to 5 gm of copper oxide wire particles in sheep was shown to reduce *H. contortus* fecal egg counts [69]. However, besides its limited usefulness, the use of 4 gm of these wire particles in late pregnancy was reported to threaten the life of multiple born offspring [70].

Condensed Tannins Containing Forage: In several studies, *Sericea lespedeza,* a condensed tannin-containing forage, has been used to decrease parasitism lower total worm burdens, fecal egg counts and larval development in goats [71]. Similar results were obtained using quebracho extracts except for no difference in worm number was noted [72]. Another study using quebracho extracts exhibited positive results, such as a reduction in fecal egg counts in sheep and goats [73].

On the other hand, plant extracts such as condensed tannins, which are secondary tanniferous plant metabolites, have been found to reduce *H. contortus* fecal egg counts and the number of eggs per female worm in goats [72]. Similarly, flower extracts of *Calotropis procera* have shown excellent anthelmintic activity against *H. contortus* in sheep [74].

Targeting Micro - Environment

Grazing Strategy: Alternate grazing of different host species and alternation of grazing and cropping are management techniques that can provide safe pasture and give an economic advantage when combined with anthelmintics [64]. Studies in the wet tropical climates of several Pacific Island countries showed that peak larval concentrations of *H. contortus* and *Trichostrongylus* species occurred on pasture about one week after contamination, but fell to barely detectable levels within 9 weeks [66]. Based on this, a rotational grazing system was designed which has resulted in a significant reduction in fecal egg counts as well as the number of anthelmintic treatments needed per year [65].

However, in many parts of Africa, communal pastoral systems do not allow for regulated grazing as a means of lowering exposure to infective larvae on pasture. Growing human populations and livestock densities coupled with the frequent drought in some regions necessitate unregulated animal movement in search of green pasture and drinking water [75]. The exploitation of refugia through alternate grazing of cattle and sheep, or sheep and goats to reduce pasture levels of infective larvae or dilute populations of drug-resistant strains of parasites, could be of great value in any management program [57].

Biological Control: Use of Fungal Spores: One example of biological control against gastrointestinal nematodes is the use of some species of nematophagous fungi with the potential to reduce nematode larval populations on pasture by using these either as their main source of nutrients or as a supplement to a saprophytic existence. there are many reviews on this topic [76]. Two groups of such fungi have been identified: there are predacious fungi, which produce adhesive or non- adhesive nematode-trapping structures and endoparasitic fungi that infect nematodes or their eggs. Among the endoparasitic fungi, those reported to infect *H. contortus are Drechumeria coniosora* and *Hapsporium anguillulae* while *Haemonchus oligospora* and Arthrobotrys breakthrough in this area was reported by several studies using the species, *Duddingtonia flagras* [77].

This predacious fungus produces three- dimensional sticky networks, which tightly traps free-living nematode larvae in the feces ultimately resulting in their death. Unlike difficulties associated with the use of other species of fungi, several authors have reported the successful passage of *D. flagrans* chlamydospores in the feces of sheep after oral drenching [53]. Despite its appreciable degree of efficacy, this method of parasite control is still not widely applicable. This may be attributed largely to the requirement for continuous oral or in feed dosing with fungal spores to achieve the desired level of efficacy [77].

Besides, the chlamydospores have a relatively short shelf life (less than week I) in a moist environment, which enables the fungal spores to germinate and become vulnerable to degradation during their passage through the animal host [76].

Improving Host Resistance

Vaccination: Control of gastrointestinal parasites by vaccination has been a long- term objective of many parasite research programs. Ideally, vaccines should have high efficacy and be commercially viable for their proposed use in the livestock sector. Several GI nematode proteins have been tested as potential vaccine products. In general, these molecules have been divided into two categories. Those termed 'natural antigens' or 'conventional antigens' are recognized by the host during infection and are targets of the naturally acquired immune response whereas molecules which are normally not recognized, or which do not induce an immune response during a natural infection but which may serve as targets of the immune response generated against them, are termed 'concealed' or 'hidden' antigens [78].

Natural antigens are constituted mainly of worm surface antigens or excretion/secretion products. Vaccines for *H. contortus* based on natural antigens can generate some level of protection, which although likely to significantly reduce pasture contamination, may not be sufficient to protect young lambs from severe hemonchosis [79].

The majority of concealed antigens of GI parasites described so far are components of epithelial cell surface membranes of the digestive tract of *H. contortus.* Antibodies directed against these molecules following immunization and ingestion of blood by the parasites have proven to be effective in reducing worm burdens. In these early studies, a serum transfer experiment suggested that the effectors' mechanism was serum antibody, which bound to the brush border membrane of the parasites' intestinal cells and sheep, which had acquired immunity to previous *H. contortus* exposure, did not recognize the gut membrane proteins suggesting that these are normally hidden from the host. A more comprehensive review of gut-associated membrane antigens is given by Laing *et al.* [80].

One of these molecules, H11, is a 110 kDa integral membrane protein expressed on the intestinal microvilli of the parasitic stages of *H. contortus* and homologues have been identified in *T. circumcincta* [81]. This molecule has been cloned and characterized as an aminopeptidase localized in the brush border of the epithelial cells. The H11 vaccine is apparently effective in all age groups of sheep and against different isolates of *H. contortus*. Other gut-associated antigens such as the 1000 kDa *Haemonchus* galactose-containing glycoprotein complex (H-gal-GP) and the 46 and 52 kDa (P46 and P52) glycoproteins have excellent efficacy in reducing FEC and worm burdens [81, 82]. The DNAs encoding H11 as well as most of the components of H- gal -GP have been expressed in *E. coli* but, unfortunately, none of these recombinant proteins have been reported to be protective [80].

Regardless of the promising results achieved over the years, especially in terms o vaccine efficacy, we are still waiting for the release of a commercial product. However, its hematophagous nature makes *H. contortus* more prone to gut-associated vaccines compared to other GI nematode parasites, the complex nature of its antigens, involving extensive glycosylation, has probably precluded their molecular cloning at a commercial level. Besides, the requirement for various adjuvants and repeated injections that could raise the cost of vaccination, have created considerable difficulties in the realization of GI nematode vaccines [79, 80].

Breeding for Resistance: The other promising angle, both for the developed and the developing livestock sector, is the selection of breeds or lines of sheep for parasite resistance. There is a sizable body of evidence for the existence of genetic variation in resistance to gastrointestinal nematode parasites both between and within breeds and selection for parasite resistance has been successfully demonstrated in Australia and New Zealand [30]. The benefits of such selection arise from the effects of having fewer and less developed worms or greatly reduced fecal egg counts, which in turn leads to a reduced impact on production, a decreased requirement for chemical control and reduced contamination of pasture by infective larvae [33].

In this respect, although possible lacking the productivity and performance capacity of their counterparts in temperate regions, several indigenous tropical breeds of livestock have the genetic ability to tolerate or resist disease, a potential developed through natural selection. The long - term exposure to GI nematodes in endemic areas coupled with their adaptation to harsh environmental conditions and low levels of nutrition have allowed them to survive in the regions in which they exist. Similarly, within populations of animals generically determined differences in parasite resistance have been reported. Such animals may serve as a potential nucleus for selecting *Haemonchu contortus* resistant sheep [82].

Several markers such as FEC, worm burden, peripheral eosinophil count and antibody levels have been suggested to identify animals with increased resistance to infection and the results using FEC as a marker are promising. However, as a selection trait, FEC has practical limitations and its use may incur production penalties through withholding drench treatment for prolonged periods. Furthermore, FEC and be influenced by the level and composition of a natural nematode challenge and the expression of the immune response [83].

Moreno *et al.* [84] have detected a for resistance to *H. contortus* on ovine chromosome 5 in the INRA 401 x Barbados Black Belly back cross lines. Studies of both the cellular and humoral responses will be of paramount importance in the understanding of the mechanism of resistance. Hence, there is still much to be done to identify the best markers of resistance for use during selection processes [85].

CONCLUSION AND RECOMMENDATIONS

Haeonchusis contortus cause great economic loss is shoats with the causative agent of *H. contortus.* It takes 21 days after the ingestion of its infective agent L3. Live in abomasums of shoats and irritate each worm suck blood. Besides weight loss, anemic, bottle jaw, slow growth, poor wool, quality occurs. it can be identified by the use of PCV, fecal egg count, worm count and identification and effective management of internal parasites can't be accomplished by using only one management factor, it is a combination of factors that will produce the most effective defense against internal parasites. Anthelmintics should be used only to treat animals when necessary and should be thought of a limited resource to be used sparingly. Proper pasture and animal management is a key component to managing internal parasites in sheep and goat operations plus vaccination, copper oxide, feeding condensed tannin-containing forage and use parasite trapping fungi.

It is known that hemonchosis cause great economic loss in shoat so, farmers should trained and award by veterinarians and animal health assistants on how to control parasite rather than curing. Again Ministry of Agriculture (MOA) and Non-Governmental Organisation (NGO) should help the owners. More ever, the farmer should feed his sheep and goats with very good nutrients, have to use rotational grazing of their pasture land, use multiple species and besides anthelmintics for prophylaxis purposes.

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