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Current approach in the control of helminthes of ruminants

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Abstract
Worldwide, parasitic diseases are the most common problems affecting animal health and performance due to organ rejection, zoonotic diseases, and enormous economic losses related to animal products. Various control methods such as chemotherapy and prophylaxis are the most widely deployed control methods to minimize the damage caused by these diseases. However, the development of drug resistance, price, availability, and drug residues hinder the effectiveness of this approach. In recent years, the focus has shifted to a more flexible approach, i.e., integrated pest management, i.e. a combination of chemical, managerial and biological measures, taking into account various factors as above. The goal of biological control is to reduce pest populations to below clinical and economic thresholds because it leads to a pest-free life in grasslands. Examining potential approaches to control and prevention is one of the goals of this article.

Keywords: Parasitic disease, integrated control

Introduction

Providing enough food for humans is a serious problem facing scientists today. The disease is a major limitation to the increased production of food of animal origin for human consumption. It must therefore involve improving livestock productivity through increased research in disease control as well as nutrition and genetics. Without effective control of parasitic disease, the non-reproductive animals will not able to realize their genetic potential in using food for growth and reproduction [36]. Worms are extremely large and are found around the world as parasites of humans and animals.

They are the cause for harming animals due to their pathogenecity, nutrient sharing, susceptibility to other diseases, and organ damage due to mechanical action or inflammatory response [10].

Since livestock must be raised on pasture year-round and the climate is conducive to the survival of infectious stages, parasitic diseases are regarded as a significant source of economic loss in Ethiopia. According to a review of the available literature, parasitic diseases should be viewed as one of the main obstacles to livestock productivity because they are thought to cost the livestock industry about $400 million yearly. Exports of livestock and meat from Ethiopia to foreign markets [35].

In the past, using medications and pesticides to combat parasitic diseases in livestock was the main strategy. The emergence of parasites that are resistant to medication, the rising cost of new products, and issues with toxicity, environmental pollution, and residues have all led to changes in control techniques in recent years. For the reasons stated, control methods now adopt a more multidisciplinary approach, especially integrated control of helminthes [38]. Therefore, the purpose of this article is to review and synthesize information on integrated helminth control measures.

Control measures against helminthes in ruminants

In terms of pest control, this entails bringing the parasite population in the host down to levels below those that result in monetary loss. It takes a systematic understanding of the epidemiological, environmental, and host imperviousness against reinfection factors that govern grassland larval populations to accomplish this effectively. The importance of control are i) to avert at risk hosts from being profoundly exposed, ii) decrease grazing land pollution, iii) play down the effects of parasite load and iv)promote the improvement of viable host immunity [34]. This ambition is achieved by integrating: grazing management, ant-worm utilization, immunity induction, and nutrient management [30].

Attention for control of helminthes

Epidemiology: Good knowledge of parasitological epidemiology is the principal situation for successful accomplishment of sound and sustainable helminth manages programs in forage animals, established through wide-ranging research and field testing. Important factors influencing helminth epidemiology include (i) changes in animal husbandry, which increase the burden of parasitic diseases, (ii) nutrition: Underfed animals are more vulnerable to internal parasites and to severe worm infections due to their incapability to rapidly clear the infection. (iii) Regular seasonal changes help predict and prevent pest infestations. Renewal and re-infection are influenced by two main factors, namely the presence of young animals that are susceptible to the disease at the time when they are born and how measuring circumstances affect their natural phases. Because of parasites, the population of parasites will grow quickly if the breeding season falls during circumstances that are quantifiably conducive to the growth and survival of free-living stages. (iv) Hypobiosis (discontinuation): is an adaptation that allows eggs or larvae to undergo stage transitions without disturbance. If sudden development of adult worms occurs again, this could lead to severe contamination of pastures and large numbers of host worms at a time when the likelihood of pasture infection may be quite low [4].

Reduction of biology and increased risk of egg laying as well as the use of anthelmintic to prevent helminthiasis have resulted from new discoveries in parasite epidemiology concerning infection patterns, worm life cycles, survival of infected larvae on pasture, and the number of worm generations annually.

Life cycle

Understanding certain aspects of the worm life cycle is an important factor to consider before implementing control measures. The life cycle includes spending part of their lives inside the host and on grasslands. Rather than emphasizing the importance of seeking multiple of control, a somewhat closed examination of the lifecycle and its division into stages seems to be effective [17].

Possible control methods

Integrated control

Complete reliance on a single control technique has confirmed to be weak and very costive in the long term. Historically, chemotherapy and prophylaxis have been the for the most part widely used disease control methods worldwide. Unfortunately, this strategy has not been as successful due to issues with drug residue, increased drug prices, unavailability, and the growth of drug resistance. The focus has recently shifted to a more adaptable approach, particularly integrated pest management, which calls for the flexible and appropriate application of all available control techniques. Appropriate for the economic climate and local conditions. If monitoring and cleaning protocols are in place, these may include biological, immunological, mechanical, genetic, and chemical measures [15].

The idea behind integrated pest management is to use grazing management to reduce the amount of time that the host is in contact with infectious larvae in the field, thereby strengthening the host's defenses against parasitic infection by depending on filters. Manipulation of nutrition or selective genetics [31].

Valence

The treatment of various deworming medications utilized in various control strategies is the foundation of this technology. There are numerous efficient dewormers on the market, some with targeted deworming properties and others with broad-spectrum effects. A growing number of medications are now available that are effective against captured or dormant larvae in addition to the many contemporary anthelmintic that are effective against adults and larvae. But because they are expensive and have a tendency to impede the host's natural immune system, anthelmintic might not be the best option for treating helminth infections [36]. Anthelmintic are generally used in medicine to treat or prevent illness. Prophylactic and strategic treatment is the two distinct preventative techniques [19]. Strategic management: In ruminants, parasitic diseases typically manifest during or soon after the larval stage's peak. This mostly takes place in the wet season. Weather has a major impact on when strategic management should be implemented because it affects the growth, survival, and dispersal of free-living stages. Consequently, the treatment is initiated when the majority of the parasite population is present in the host and pasture larval infection rates are low. As a result, there are fewer parasites that are susceptible, which could put more pressure on selection for resistance [6].

Considering geographic disparities is crucial when deciding when to implement a strategic plan. When the grazing season begins in temperate climates, chronological treatments are applied at intervals resembling the pre-patent or pre-patent periods. The length of the drug's residual effect increases upon patenting. Similar chronological treatments are applied at the start of the wet season in the tropics, and additional treatments are applied when the grasslands are almost completely barren during the dry season. In addition to being administered therapeutically to eradicate the worms, these treatments also serve as a prophylactic precaution to stop pasture contamination in the future and lower the chance of reinfection [7]. Based on nematode epidemiology, the most practical methods for implementing strategic control are

(i) Treat young animals with anthelmintic until weaning and when they are likely to be nutritionally stressed. (ii) Treatment of older livestock, aimed at preventing pasture contamination and clinical helminthiasis. (iii) Treat pregnant animals to avoid infection and avoid the risk of a new generation being susceptible to the disease. Strategic treatments are usually carried out twice or four times a year, depending on the climate, management Depending on the climate, management techniques, and nematode prevalence in a given area, strategic treatments are usually carried out two to four times annually [8].

Strategic treatment: Preventive care is administered in response to anomalous alterations in animals, such as shifts in the local population, diet, or climate. There is a growing consumer demand for food products free of contaminants. Drug resistance in helminthes is caused by the use of anthelmintic medications [33].

Non-chemotherapeutic approaches

Non-chemotherapeutic methods

Alternative non-chemical pest control methods will become more necessary due to the issue of anthelmintic resistance and mounting consumer demand for high-quality, residue-free animal products. Biological control [8] and management techniques (feeding, grazing, and husbandry) are some of these techniques [8]. Improved agricultural methods: Grassland management approach has not been fully put into practice due to the ease with which farmers use chemicals and the increasing demand for land. Grazing behavior can influence disease transmission, which is observed in cattle during reproductive Dictyocaulus infection.

Overcrowding during grazing is one of the factors that make animals vulnerable to parasite attacks, because when pastures are too crowded, they have to uproot every piece of greenery. Immature animals are very discriminating; Twin lambs often have more severe infectivity than lambs [17].

Pasture management strategies that work well when combined with anthelmintic treatments are administered as suggested by epidemiological studies and are aimed at keeping pasture contamination levels low. Short, nutrient-poor pastures are susceptible to infestation because the density of larval infection will be maximized and larvae concentrated on the grass will be captured along with roots and soil [28].

Rotational grazing is the first control strategy used to lessen these effects is rotational grazing. With this method of grazing management, pastures are divided, and each paddock is grazed for a brief period of time before being rested for a comparatively longer period of time. Cattle should be rotated, usually once a week, from highly contaminated pasture to clean pasture, depending on the parasite epidemiology. In temperate climates, this is probably not feasible because, depending on the climate and season, a meaningful decrease in infection rates in pastures may take three to nine months. However, because the larvae have a limited survival time, it is extensively used in humid tropical grasslands. Because the development from egg to infectious larvae can occur in as little as 4 or 5 days, this enables the innovation process to be designed to be brief enough to prevent re-infection in a single step. When implementing the "5" crop rotation system, this tactic ought to be coupled with helminth treatment. A secondary control is replacement grazing to minimize this effect. Apart from sheep and goats, which have the same host species, all farm animals have their own scavenging fauna. Goats and cattle can alternately browse on the same paddock if grazing is not preferred. Larval survival is prolonged by cool, rainy weather, and in temperate climates, this grazing system is less effective than in tropical and subtropical areas at thwarting parasitic plans. When the new species or age is introduced, this might be reciprocal with anthelmintic treatment [12]. Early weaning is another approach to reducing the impact of parasite loads. In herds where nematode disease is the main problem, early separation of the most sus ceptible part of the herd (Calves and lambs) from their mothers and grazing on clean pasture (Tables) is a useful method [29]. By forcing animals to graze closer to soil and manure, controlling stocking density helps reduce the crash of parasite loads and the high number of infectious larvae that are consumed [6]. Nutritional management: Parasitic diseases of ruminants are production-related diseases, aggravated by malnutrition. Research shows that better nutrition reduces production losses and mortality from parasitic worms in livestock.

Strategic feed supplementation can have long-term advantages, particularly for animals that are more susceptible (Young cattle and grazing animals). Rumen function is severely compromised by low mineral content and non-protein nitrogen supplementation. In addition to increasing food intake, this gives the small intestine more protein for absorption and digestion. Reduced worm egg production and a lower degree of infection on pasture can be achieved by livestock that are able to manage parasites. Increased immunity acquisition and resistance to reinfection are the primary outcomes of protein supplementation, and these factors are linked to an enhanced cellular immune response in the gastrointestinal mucosa [11].

Biological control

The use of one objective living parasite to control another, lowering the organism's population expansion below a threshold and causing the least amount of clinical harm, is known as biological control. The majority of animal parasite control tactics for gastrointestinal nematodes focus on the parasitic stages. Open grazing areas, on the other hand, are the focus of parasitic nematode biological control. Therefore, the goal of biological control is not to eradicate a specific parasite organism but rather to lower the density of parasites below clinical thresholds and possibly below the economic threshold that causes harm. A product must meet several requirements in order to be expanded for use in a synthetic biological control approach, including the capacity to grow, survive in the gastrointestinal tract, and exhibit activity in feces [1]. When helminth growth is controlled by other methods, long-term parasite reduction shows promise. For example, the Nematophagus fungus has been shown to significantly reduce parasitic nematode populations. These fungus are comparatively simple to cultivate and can be released in a controlled approach into the intention organism's atmosphere.

By reducing pasture infestations, the fungus *Duddingtonia flagrans* successfully manipulates the most significant gastrointestinal nematodes for grazing livestock. This is one of the more promising approaches to addressing the issue of medication resistance. Fungi can be fed to animals in controlled systems, feed blocks, or supplements. Once inside the ruminant's digestive tract, the fungi germinate, spread, and absorb excrement. Before they migrate to pasture, a large number of larvae become infected [21]. All parasitic nematodes of livestock have a life-cycle that includes not only a parasitic phase within the host but also a free-living phase on pasture. Biological control agents could potentially affect any stage, it seems logical that the free stages of the parasite life cycle hold the greatest promise. Consequently, these organisms found in the external or internal free-living environment will probably be the subject of the majority of future research on life control agents against parasitic nematodes in animals. Indeed, a wide variety of organisms can have an impact directly by consuming free-living stages as food or indirectly by destroying habitat (Feces). The majority of these biological control agents can be found in the earthworm, nematode, bacteria, and virus groups [2].

Mushrooms used to control biological nematodes

The use of Nematophagus fungi in biological control as a preventative measure lowers pasture infection levels. After parasites are acquired by grazing animals, it has no effect on them. This would be an inexpensive, long-lasting non-chemical control technique that would be especially useful for overnight animal confinement. Fungi can be added as a food block or supplement to a diet in order to function as a biological control in an integrated program against gastrointestinal nematodes. Research and development on this technology are presently underway [2].

Microscopic fungi known as nematode fungi are capable of ensnaring, eliminating, and breaking down nematodes. They attack nematode eggs and cysts using hyphal tips, while worm-like nematodes are trapped using special hyphal structures known as spores or traps. Nematophagus fungi are divided into three major groups: (i) Fungal traps use specialized morphological structures known as traps to catch free-living nematodes. (ii) Adherent spores from endoparasitic fungi infect nematodes, and (iii) hyphal tips from oomycete and cyst parasitic fungi infect these stages. The process by which they infect nematodes involves the adhesion of trap structures to the nematode host's surface, followed by the penetration, destruction, and digestion of nematode tissues. The fungal Nematophagus requires the secretion of extracellular enzymes like chitinase and serine protease in order to successfully parasitize both free-living nematodes and their eggs. Endoparasites mainly rely on nematodes for nutrition, while many trap-forming and egg-parasitic fungi can survive saprophytically in soil [23].

When Danish researchers tested the impact of the fungus *Arthrobotrys oligospora* at varying doses of spores mixed on the surface, primarily on parasitic nematodes in cattle and other livestock species, they discovered that 250 and 2,500 conidia per gram of surface significantly reduced spore counts. Larvae of *Cooperia oncophora* grew at 70% and 99%, respectively, in fecal culture. The motility of the infecting larvae affects fungal scavenging activity, which is not species-specific [20]. Unfortunately, various attempts to examine the mycelium and spores of *Arthrobotrys oligospora* have failed because these structures are destroyed in the host animal's gastrointestinal tract.

For stable sheep infected with mononucleosis *Ostertagia circinata* or Heamonchus contortus, a high dose (470–680 grams of fungal material on millet) of one of three different fungal species (*Arthrobotrys musiformis*, Arthrobotrys Torture, and Dactylaria Candida) was offered.

This then results in the survival of the Arthrobotry torturer in the gastrointestinal tract at levels high enough to significantly reduce the number of Haemonchus contorts in the fecal cultures. Another area of research concerns *Duddingtonia flagrans*. This predatory fungus produces many hard, thick-walled, resting spores that are capable of passing through the digestive tract and remaining in the stool. Once stimulated, they germinate and spread rapidly on and in fresh feces and capture the infectious larvae of most gastrointestinal worms. Species, including Cooperia, Ostertagia, Heamonchus, Nematodirus, and Trichostrongylus, before they can migrate to grasslands [16].

A very high dosage of *Drechemeria coniosspora* (108 candida per gram of stool) was used for stool culture, only third-stage infectious parasite larvae, lacking the additional protective cuticle (Second instar), were infected fungus. Another endoparasitic fungus, *Harposporium anguillulae*, produces very small, half-moon-shaped spores that reside in the digestive tract of feeding nematodes and, after germination, completely digest the victim before passing through cuticle to produce new spores on short spores. Laboratory studies showed that at a dose of 3 x 105 conidia/gm, the number of *Haemonchus contortus* larvae recovered was significantly reduced. In general, the three main groups of nematode fungi and the nematodes they control are shown in the table below [27].

Table 1: Show the fungal species, parasites species, predacious and *Ostertagia*

Fungal species	Parasites species
Endo parasitic fungi	*Heamonchus*
Drechemeria coniospora *Harposporium anguillulae*	*Trichostrongyluscolubriformis*
Predacious fungi	***Ostertagia***
Arthrobotrysoligospora *Arthrobotrys misinforms* *Arthrobotrysrobusta* Egg parasitic fungi *Verticillium chlamydosporium*	*Dictioyocaulusvivipars* *Heamonchuscontortus* *Oesophagostomium species* *Oesophagostomiumcircumcinta* *Heamonchuscontortus* *Heamonchusplacei* *Ascaris suum*

Bacteria and viruses as biological control of nematodes

During sporulation, Bacillus thurnigienesis, a complex aerobic spore-forming bacterium, produces crystals that are poisonous to insects. It has been specifically noted as a possible biocontrol agent that could be used to combat parasitic nematodes [25]. Meoidogyne and Tylenchrohynchus, plant parasitic nematodes, exhibit aberrant behavior that is linked to viruses. However, it is challenging to identify viral infections in these microscopic nematodes or to differentiate them from diseased or immobile species. There are currently many barriers to overcome in order to implement this method of biological control, even though significant viral pathogens may exist that combat the free-living stages of parasitic nematodes in animals [22].

Nematodes and cestodes under biological control: In nature, it is possible for cestodes to be naturally controlled by destroying their eggs when consumed by a large number of animals. Invertebrates like ants, earthworms, and beetles can quickly destroy the eggs or transfer them to the soil, and vertebrates that are unsuitable hosts can also do this. As there are no known successful or useful examples of biological control cestodes, more research is necessary (38). The goal of biological schistosomiasis control is to manage the intermediate host, the snail. Both parasitoids like nematodes and nematodes and predators like fish, birds, beetles, and leeches are potential candidates for biological control of snails [14].

Immunological control

Considerable resources have been allocated to studying the mechanisms of action of naturally acquired immunity against helminth infections to facilitate vaccine development as well as selection of resistant hosts [9].

Vaccine

The worms that feed on grazing animals have become resistant to drugs, which have led to a recent push to create functional vaccines. Newer technologies in gene discovery, identification, characterization, and antigen production have made this possible. The main problems hindering the development of nematode vaccines in ruminants are that vaccination with recombinant nematodes produced in a eukaryotic expression system does not induce an immune response and does not have an appropriate antigen delivery system to deliver protective worm antigens to the immune system of mucous membranes of ruminants.

Efforts to immunize ruminants against gastrointestinal helminthes through ectopic infection or homogenization of crude helminth antigens were unsuccessful in the beginning. Currently, attempts are being made to target susceptible targets on or secreted by the parasite with high-titer antibody responses [24]. Using irradiated larval vaccines, effective vaccines have been developed against tapeworm in sheep and lungworm in cattle. The most promising nematode vaccinations specifically target the bending mechanisms of Haemonchus and are referred to as "hidden gut" antigens.

Animals that are injected with this antigen, which comes from the worm's intestines, develop antibodies. These blood-borne antibodies are consumed by worms during feeding. After that, the antibodies target the intestinal cells of the worm and prevent it from processing nutrients. Several vaccines that employ hidden antigens have been created to protect sheep against Haemonchus contortus, and they offer 94% protection [26]. The drawbacks of hidden enteric antigen vaccinations include the antigen's tendency to be hidden from the host and the potential need for several expensive injections to keep antibody levels high enough to combat infection. Plus, it takes a lot of whole worms to extract a small amount of antigen, so it won't be feasible until techniques to make synthetic antigens are developed.

Homologous antigens are the first antigen that provides protection against other helminths, so using them to induce protection is another method. The best example is the selection of glutathione transferase (GTS) from Fasciolapatia as a potential vaccine antigen due to the discovery that homologous proteins from *Schistosoma japonicum* and *Schistosoma mansoni* provide animal immunity against infection. An average of 49% of the native Fasciolapatia GST isolate was used to inoculate sheep and cattle, with 29D44 being chosen as the resistant host: The interest in using and creating animals that are genetically resistant to helminth parasites has increased due to the widespread emergence of anthelmintic drug resistance and the high cost of developing new drugs. Haemonchus spiralis genetic resistance has been shown in several sheep breeds. Breeds of sheep (such as Scottish Blackface, Red Massai, Romanov, and St. Croix, Barrbadose Blackbelly, and Gulf Coast Native) and goats (Such as the small dwarf breed that originated in East Africa, West Africa, and Thailand). Due in part to their relative ability to elicit an immune response, red Massia sheep, which are native to Kenya, have been demonstrated to be the breed most resistant to disease. In order to create disease-resistant stocks, selection for disease resistance can be combined with any other necessary strategies [18].

Exclusive use of resistant varieties or in cross-breeding programs will certainly provide greater resistance to parasitic infections, but some level of production may be sacrificed. It has been shown that resistant lines are selected within breeds in sheep (Merino and Romney) and goats (Scottish Cashmere). Animals within breeds get older and more immune system-capable of fending off infections, which makes them more resilient to infection [13].

Conclusion and Recommendation

Information of the epidemiology of parasites present in a known spot is essential for applying control actions in that area because it helps forecast when to implement control measures before Animals become affected by helminthes. Some believe that the era of chemotherapy is coming to an end due to the growing threat of drug-resistant parasites, the rising cost of newly developed chemicals, and issues with toxicity, ecological contamination, and residues in animal products. Therefore, it is possible to successfully reduce the number of drug treatments required as well as the infectivity of grazing land by combining timely anthelmintic treatment with good pasture management, breeding, and biological control.

Even if biological control is inconsistent and slower in action, it represents a potentially effective alternative way of control of nematodes. Therefore, the control programs should be designed to integrate biological options with other available methods of control. Based on the abovementioned precise information assembled, the next points were suggested:

- Any advance regarding existing pest control options ought to be studied in detail taking into account specific agro-ecological and financial considerations.
- Avoid using anthelmintic drugs regularly, continuously and indiscriminately to avoid drug resistance.
- Special attention should be paid to implementing non-chemotherapy approaches, such as vaccination and bio-selection of resistant hosts.
- Study is required because resistance to helminths is an essential component of control and much work needs to be done in this area.

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