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Various control strategies of *Haemonchus contortus* parasite in small and large ruminants

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ABSTRACT

Haemonchosis has emerged as a major production barrier in sheep farms throughout the world's tropical, subtropical, and temperate climates. *Haemonchus contortus's* survival and, consequently, the onset of the disease in the animal, are influenced by several intrinsic and external factors. In general, anthelmintic drugs are heavily used to control nematode infestation in ruminants. Due to excessive and continuous use of anthelmintics, drug-resistant helminths strains are produced. This has led to the development and use of various halminths control strategies, including vaccines, plant extracts, biological agents, and essential oils. The ultimate objective of such control startegies is to increase production while lowering the risks associated with medication resistance, consumer safety, and environmental issues. This review aims to emphasise the many approaches used to treat haemonchosis in ruminants, the practical restrictions connected with both control programs and the parasite and its environment, as well as internal and external factors.

Introduction

Haemonchus contortus is the gastrointestinal parasite with the highest pathological and commercial significance. This nematode is an abomasal, blood-feeding parasite that can also spread to other ruminants like sheep and goats including livestock and reindeer (1). The blood-sucking nature and heavy burden of the nematode cause anaemia, reduced production, and increased mortality rate in lambs and young animals in situations where few or no control measures are use. This parasite also has the capability to produce a bulk of eggs, which results in pasture contamination (2). Numerous techniques have been employed for a long time to lessen the dangers brought on by haemonchosis and general gastrointestinal nematode infestations in all types of ruminants. The most widely used approach to gastrointestinal nematode control is the use of anthelmintics (3). However, a substantial amount of research is focusing on alternative or complementary control techniques due to factors including the growth of drug-resistant strains, issues with medication residues in food of animal origin, and ecotoxicity.

Chemical Control of *H. contortus*

Anthelmintic drugs are frequently used either to treat current ailments or clinical outbreaks (4). The use of various doses for different animals against a wide range of parasites has advanced significantly since the development of contemporary anthelmintics. The methods, applications, actions, and duration of drug administration all contribute to the relative success of these treatments. Anthelmintics are quite often used orally but these drugs can be given given intravenously in the form of solutions. They can also be given in the form of paste and bolus, but their method of application may be changed (5). Several medications have been demonstrated to completely eradicate *H. contortus* during the early stages of their use, and several still do so in certain regions of the world. Researchers and scientists around the world have discovered best anthelmintics (thiabendazole, levamisole, morental tartarate, benzimidazole, avemectin, milbemycines) who achieved the maximum (100%) effect against GIT nematodes especially *H. contortus* in ruminants (6). But the efficiency of these priceless and highly powerful drugs is in jeopardy. Their prolonged use, poor management, and imbalance dosage have decreased the effectiveness and efficiency of these priceless and highly powerful drugs against *H. contortus.*

However, a substantial amount of research is focusing on alternative or complementary control techniques due to factors including the growth of drug-resistant strains, issues with medication residues in food of animal origin, and ecotoxicity.

Alternate Control Strategies

Vaccination

High efficacy and commercial viability are ideal requirements for vaccinations for their intended application in the cattle industry. Several gastrointestinal nematode polypeptides and amino acids (proteins) have been examined as possible preparation (vaccine) ingredients. These molecules have often been divided into two categories. The first category is the hidden or concealed antigens which include different particles that are not recognized by the host immune system, or they do not trigger an immune response even during an infection. The second category is the natural antigens, which are recognized by the ruminants during infection and produce naturally acquired immune response (7). Natural antigen-based *H. contortus* vaccines can produce some amount of immunity which on one side reduce pasture contamination significantly but on the other side it is insufficient to save newborn lambs against during severe haemonchosis.

The bulk of hidden antigens of GIT nematodes that have been described thus far are parts of the epithelial cell surface membranes (ESM) that line *Haemonchus contortus'* digestive tract. Following immunization and blood consumption by the parasites, antibodies targeted against these compounds have been shown to be beneficial in lowering worm burdens.

Use of copper oxide (CuO)

Alternative therapies have been employed against parasite disorders for a long time with significant effects. The example includes the usage of CuO wire particles. In a research trial sheep were given CuO wire particles in 2.5 to 5 grams, which lowers the egg burden of *H. contortus* in feces. The usage of 4 to 5 grams of these CuO wire particles in the last trimester of pregnancy was very useful in lowering the burden of worms in newborn babies but on the other hand, it has limited application because of its side effects (8).

Use of plant extracts

Almost all plants are rich in organic and volatile substances. Research studies have revealed that the chemical compounds i.e., monoterpenes and sesquiterpenes obtained from the plant extracts have been found very effective in adult and larval mortality, oviposition reduction, and reproductive index of *H. contortus* and *T. colubriformis* worms in sheep. In a similar vein, *Calotropis procera* flower extracts have demonstrated excellent anthelmintic action against the above-mentioned helminths (9). Various varieties of plants are available around the globe, but which plant is effective against GIT nematodes and useful for animal health is hard to find for the researchers, but they are trying their best to get potential botanicals for the betterment of livestock. Several plant extracts have been found so far which are very effective against GI nematodes and reduced worm load.

Control through Nematophagous Fungi

This is a technique that uses biological agents to lower parasite levels in the host or on the pasture, reducing the need for anthelmintics more frequently. Some nematophagous fungal species have the potential to lower nematode larvae on pasture by consuming these as a source of nutrition. These fungi fall into two categories: endoparasitic fungi, which infect nematodes or their eggs, and predator fungi, which generate sticky and detachable nematode-trapping configurations. *Drechumeria coniospora* and *Harposporium anguillulae* are two endoparasitic fungi that have been found to infect *H. contortus*, whereas *Arthrobotrys oligospora* and *A. robusta* prey on distinct species of *Haemonchus* (10).

Control through Essential oils

Essential oils (EO), also known as volatile oils, are frequently produced from plants that are used as food, medicine, herbs, or spices (11). Different plants have different primary plant tissues for EO deposition. They could be bark, seeds, roots, rhizomes, seeds, flowers, or leaves. Various extraction methods are being applied to obtain the essential oil which include solvent extraction, steam distillation, and hydro distillation. Chemically, the EO compounds are a combination of terpenoids, primarily monoterpenes (C10) and sesquiterpenes (C15), but they may also contain diterpenes (C20), as well as a large number of lactones, aldehydes, aliphatic hydrocarbons, acids, alcohols, acyclic esters,

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non-nitrogenous compounds, and sulfur-containing compounds (12). The chemical components of EO in each plant may differ based on the tissues of the plant, genotypes, cultivars, age, environment, and geographies. Essential oils obtained from the leaves and blossoms of *O. vulgare* and *T. vulgaris* possess thymol in 64% and 20-55%, respectively (12). EOs can be extracted from a variety of plant parts (seeds, rhizomes, tree bark, tubers, and buds). EOs are extracted from the seeds of medicinal plants like *Nigella sativa* L. and *Carum carvi* L. to create black cumin seed oil and caraway oil, respectively. EOs from *Eucalyptus staigeriana* were used in a study on sheep that had been exposed to the *Haemonchus contortus* parasite. The outcomes demonstrated that EOs from *Eucalyptus staigeriana* might inhibit the growth of worm eggs and larvae and fight nematodes in sheep's digestive tracts. Similar results were found in a study by which demonstrated that EOs from *Lippia sidoides* improved sheep's resistance to nematodes such as *H. contortus* and *Trichostrongylus spp*. (13). Additionally, adding roughly 3% flaxseed oil to sheep's diets could lower their fecal egg count. To either improve rumen function or to lessen the use of anthelmintics in ruminant, it is very important to choose the most effective plants that contain substances for their proper dosages and uses. Additionally, it is also difficult task to assess the potential efficacy, cost for farmer, and safety level of these essential oils for ruminants.

Conclusion

Due to its widespread distribution, haemonchosis has become a significant productivity constraint in sheep farms in different regions around the globe. Therefore, in-depth epidemiological studies are necessary to tailor the grazing management options to the local farming systems. The commercialization of plant extracts, essential oils, vaccines, and biological control agents seems unlikely soon. The likelihood that these goods will reach impoverished sheep farmers in the tropics and subtropics is doubtful for a variety of reasons, including a lack of veterinary services and availability, even though they might be of considerable advantage to the world's huge sheep industries and, consequently, to consumers.

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