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Popular Article

Alternative Methods to Control Helminthes of Veterinary Important

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Abstract

Nematode infections in animals, pose significant challenges to global livestock production, impacting both animal health and overall economic sustainability. Conventional methods of nematode control often involve the use of anthelmintics drugs, raising concerns about drug resistance and environmental contamination. The sustainable control focuses on the integration of alternative control methods this includes the implementation of targeted selective treatment protocols for reducing unnecessary drug use and mitigating the risk of resistance development. Additionally, the utilization of bioactive plants and feed supplements with natural anti-parasitic properties presents a promising way for sustainable nematode control in grazing animals. Animal husbandry practices that enhance resilience and immunity, such as rotational grazing and breed selection for resistance, nutritional management, vaccination plays a crucial role in minimizing nematode infection risks.

Keywords: Nematodes, sustainable control, breed selection, bioactive plants, vaccination

Introduction

Small ruminants hold an important niche for sustainable agriculture in developing countries and support a variety of socioeconomic functions worldwide. India has an estimated sheep and goat population of 65 million and 135.17 million respectively, Gastrointestinal tract (GIT) parasitism in sheep and goats is of paramount importance because small ruminants' rearing has been a major source of income especially to the marginal farmers of the country These parasites cause both acute infections with a rapid onset and high mortality levels and chronic infections, which are commonly subclinical and may lead to insidious and important economic losses via reduction of live weight gain, reduced wool and milk production, and poor reproductive performance This problem is severe in tropical countries due to highly favorable environmental conditions for helminth transmission (Singh *et al*.,2013) Parasitic nematodes constitute one of the greatest disease problems in grazing livestock worldwide. Among them, Gastro Intestinal Nematodes remain a major threat for ruminant production, health and welfare. Conventional nematode control strategy is based on repeated use of synthetic anthelmintic drugs.

Synthetic Anthelmintics

There are a wide range of commercial anthelmintic formulations available in the market under different brand names. Hence, for adopting practical measures to prevent anthelmintic resistance one must know the mode of action of a particular anthelmintic.

Factors to be considered before administering an anthelmintics, health condition of the animal, type of parasitic infestation, dose and route of drug administration. Various groups of drugs such as Piperazine (ex. Piperazine salts), Benzimidazoles (ex. Albendazole), Salicylanilides (ex. Closantel), Macrocyclic lactones (ex. Ivermectin) and Imidazothiazoles (ex. Tetramisole) have been shown to be successful (almost 100%) in eliminating most species of nematodes (Getachew *et al.,* 2007).

Constraints Of Anthelmentics

- Drug residues
- Effects on environment
- Resistance

So, there is need to develop novel alternative approaches for sustainable control of nematodes

The Goal – Parasite Control Program

1. To minimize the risk of parasitic diseases.
2. To control parasitic egg shedding.
3. To maintain efficacious drugs and avoid further development of anthelmintics resistance as much as possible.

Nematodes Affecting Ruminants (sheep, goat, cattle):

Gastrointestinal nematode (GIN) – Major ones: *Haemonchus contortus (*sheep*), Trichostrongylus spp, Cooperia spp, Ostertegia ostertegi (*cattle*), Teladorsagia circumcinta (sheep&goat) & Oesophagostomum spp.* Minor ones*: Trichuris ovis, Bunostomum spp,Nematodirus spp., Strongyloides papillosus.* Lung worms-*Dictyocaulus filaria* (sheep & goat), *Dictyocaulus viviparus* (Bovine), *Muellerius capillaris* (sheep&goat), *Prostrongylus rufescens* (sheep&goat). *Setaria spp, Onchicerca spp, Stephanofilaria spp.*

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Approaches In the Control of Nematodes

1. Housing management
2. Pasture management
3. Nutritional management
4. Breed resistance
5. Biological control
6. Vaccines
7. Alternative dewormers

1. Housing Management

Animal sheds must be well ventilated and lighted to maintain required humidity and air circulation (Madke *et al.,* 2010). In high humidity and low light there will be accelerated growth of parasites population. The animal should not be fed on the ground. Water should be clean and free faecal matter watering areas should be situated in well drained places with cemented floors. Proper drainage reduces the chances of survival of the parasites.

2. Pasture Management

Controlling of internal parasites in grazing livestock (stuedemann *et al*., 2004). Regular burning of old or grazed pasture-to obtain parasites free pasture land. Over stocking of animals in a small piece of land-increases the concentration of parasites.

Pasture Rotation and Pasture Resting

Objective of Pasture rotation not to put the animals back into the same field until the risk of infection has diminished. Paddocks: Distributing the pastures into parcels of land of varying sizes (Johns *et al*., 2004). A rest of 3–6 months must be given for infected pasture to return to a low level of infectivity. It is reasonable to graze different age group animals in different fields as it reduces the infection.

Multispecies Grazing

Sheep parasites cannot infect the cattle. Cattle parasites cannot infect the horse. Horse parasites cannot infect the goat (Christensen 2005). Each species has different grazing behaviour.

Grazing Management

Michel (1985) classified managemental strategies as preventive, evasive or diluting.

Preventive strategies

In most of the developed countries, the most common preventive manage mental strategies for control of helminthic parasites are the short, intensive treatment programme using controlled- release devices or careful application of conventional anthelmintics treatments in the first half of the grazing season for one year old calves. Controlled-release devices and conventional treatments are commonly given at turnout i.e. at eight weeks and

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again at 13 weeks respectively. An extreme form of preventive strategy is to alter the host species, like sheep and then cattle and birds over the same pasture. By this, the parasitic contamination is prevented both by anthelmintic treatment as well as by exploiting host specificity. In general, parasite species that are pathogenic in one host species may be non-pathogenic to the other host. Typical procedures involve alternation of the separate host species at intervals from two to six months usually along with anthelmintic treatment at time of alternation (Dobson *et al.*, 1987).

Evasive strategies

The evasive strategy can be defined as the removal of a moderate existing infection in animals by anthelmintic treatment and then moving the treated animals to a safe pasture, just before the population of infective larvae on the original pasture rose to dangerously high concentration (Michel, 1976; Thomas, 1982). The anthelmintic treatment helps to get rid of the existing worm population in the calves or lambs that might otherwise have contaminated the safe pasture. Generally, in temperate climates rotational grazing systems have been found to be ineffective for controlling parasitic nematodes, as the survival times of infective larvae on pasture is very long. However, in wet tropical climates, the warm, wet conditions favour rapid and continuous egg hatching and larval development.

Diluting strategies

Under the diluting strategy, the susceptible animals are allowed to graze with greater number of non-susceptible animals so that the average rate of contamination of pasture with worm eggs will get reduce drastically over a period of time. This further reduces the uptake of parasitic eggs by susceptible animals. The rare incidence of clinical parasitism in pre-weaned calves may be another example of diluting effect. Mixed grazing of cattle and sheep has been studied in relation to productivity and effect on parasite transmission. There was decrease numbers of parasites like *Ostertagia circumcincta* and *Nematodirus spathiger* in sheep that might be the result of counter balance by an increase in burdens of parasitic species like *Trichostrongylus axei* and *Cooperia oncophora* that were associated with cattle. The effect of mixed grazing in ewes and lambs with cows and calves, resulted in reduced parasitism in sheep and increased production performance in lambs.

Nutritional Management

Feeding behaviour of animals also affect the type and severity of the parasite infection. Proteins play a important role in improving the host response against nematode infection by increasing immunity. In general, 13% protein supplementation is essential for resistance and reduces the egg per gram (EPG) in periparturient period. Vit A, D and B complexes – developing the immunity against parasites. Minerals - Zn, Fe, Co & Na- functioning of immune system against parasites (Hughes and Kelly 2006). Vit A - improves the intestinal epithelial integrity Phosphorus: In general, 0.28% phosphorus on a dry matter basis, the weight gain of lambs infected with parasites was increased by 40% over those lambs fed a low (0.18%) phosphorus in diet.

Secondary Metabolites of Tanniferous Plants

Tannin is an active substance which will bound to free proteins in digestive

tract of worms or glycoproteins in cuticle which then causing physiologic impairments in motility, nutrient absorption and reproduction. Pasture plants have condensed tannins which have anthelmintic properties (Min *et al.*, 2004). Tropical legumes have more condensed tannins than temperate legumes. Sheep grazing Lotus spp., a forage high in condensed tannins, showed reduced establishment of *O. circumcincta* worms (Niezen *et al*., 1998). Reduction in appearance of nematode eggs on goat faeces with the Cassava foliage supplement has been demonstrated (Phengvichith and Preston, 2011).

Breeding Animals for Genetic Resistance Against Parasites

The use of genetic selection of ruminants for traits of resistance to GIN infection has been presented as the “ultimate tool in sustainable parasite control” (Waller and Thamsborg , 2004). Now a day’s research is going on the selection of breeds that are genetically resistant for GI nematode infections for both sheep and cattle. There are over 30 indigenous breeds of cattle in India (e.g: Rathi, Gir, Kankrej, Tharparkar, Sahiwal, Deoni, Halliker, and Haryana) and 10 breeds of buffaloes (e.g; Murrah, Jaffarabadi, Mehsana, and Surti). All these breeds show resistance to various diseases including GI parasites. Resistance can be measured by a variety of techniques, but the most common method is by estimating worm egg counts in faeces as faecal egg count has been shown to be heritable. Genetic variation to worm infection is likely to be even greater between breeds, than within breeds, of small ruminants. Hence, selective cross breeding should be promoted to develop breeds that are genetically resistant to parasitic nematode infections. Although the mechanisms involved remain to be fully understood, it is generally hypothesized that differences in host resistance relates to selection for a better immune response against GINs, which affect different stages of the parasite’s life cycle. Some authors have suggested a hypothesis that there can be negative consequences with production of animals selected for only resistance purpose against gastrointestinal nematodes. In addition, any selection process is scheduled at one specific moment with one objective and it has to take into account the local environmental conditions, as well as the breeds (Simm *et al.*, 1996).

Biological Control

Concept Of Biological Control

Biological control defined as the activity of natural enemies which include classical, un-exploited organisms (Larsen, 2006). Other methods are directed at the parasitic stages within the host, while biological control targets at the free-living stages on pasture (Waller, 2006) focusing on the faecal deposits in which eggs, L1, L2 and L3 larval stages are found. This method aims to

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establish a condition where grazing animals are exposed to a low number of infective larvae and reduce the level of nematode parasitism in livestock so that natural immunity in the animals will tolerate these low levels (Epe *et al*., 2009). They can control a target organism by reducing its population to a level that no longer causes clinical problems and economic losses. They have low mammalian toxicity, high efficacy, naturally occurring and multiply to a level that matches its target organisms (Larsen, 2006). Can avoid the issue of chemical residues in food and is an attractive option for organic farming. No negative effects on environment. However, the effect on animals requires investigation. However, there are no commercial biocontrol agents currently available for controlling nematodes in livestock anywhere in the world.

Nematophagus Fungi .

Several fungi have been known for a long time that exhibit anti-nematode properties. These consists of numerous species consisting special characters like ability to capture and exploit nematodes either as the main source of nutrients or supplementary to a saprophytic existence. However, these fungi are divided into three major groups based on their morphology and types of nematode-destroying apparatus (Barron, 1997; Nordbring-Hertz, 1988). They are predacious, endo-parasitic and egg-parasitic fungi.

Predacious Fungi

The idea of these fungi to control animal parasites was begin since 1930. By means of adhesive knobs, networks, rings on mycelium capture the nematode parasites and they are not parasites specific. The most commonly *Arthobotrys* spp. (*Arthobotrys oligospora)* and *Monacrosporium* spp. a *Duddingtoni flagrans* has been using for parasites control. The trapping activity of the fungus was influenced by the motility of the infective larvae and there was no specificity for the parasitic species (Nansen *et al*., 1996). The growth of predacious fungi is strongly influenced by temperature (Fernandez *et al*., 1999). A high dose (between of 470 and 680 gm of fungal material on millet) of one of the three different fungal species (*A. musiformis*, *A. tortur*, *Dactylaria candida*) was fed to lambs, harboring a mono infection of either *H. contortus or O. circumcincta*. The study showed a level high of *A. tortur* in the GI tract and this was enough to significantly reduce the *H. contortus* population in faecal cultures of treated lambs. The plot trials of *Duddingtoni flagrans,* another predacious fungus have shown good reduction of free-living larval stages of nematodes in cattle (Gronvold *et al*. 1993), sheep and horses (Fernandez *et al*., 1999). These daily feeding of fungal spores to grazing animals prevents build-up of infective larvae on the pasture to a dangerous level.

The fungus *Duddingtonia flagrans*

Duddingtonia flagrans belongs to a heterogeneous group of fungi in the *Deuteromycetes* family (Waller *et al*., 2006). It is a predacious fungus that produces adhesive three- dimensional hyphal networks during development, which trap the larval stages of nematodes and has shown much promise as a biological agent. This fungus has shown its ability to survive through the digestive system of ruminants as a resistant spore (chlamydospore) Chlamydospores are administered orally and deposited in faeces. It traps the free-living larval stages, which include eggs, L1 and L2 stages within the faecal deposit, and infective third-stage larvae on pastures and thereby reducing pasture larval population. The fungus has shown the ability to survive through the digestive system of ruminants as chlamydospore form The mode of action of *C.rosea* as biological control agent is not well understood. Clonostachys rosea f. rosea conidia attach to the cuticle of nematodes, germinate and produce germ tubes, which then penetrate the host body, and kill the nematode.

The bacterium *Bacillus thuringiensis*

Bacillus thuringiensis is a gram-positive bacterium, found in various ecological niches such as soil, plant surfaces and dust from stored-products. This bacterium produces crystals of proteinaceous insecticidal δ-endotoxins (**crystal proteins or Cry proteins**). Cry toxins have specific toxin effects against nematodes Different Cry proteins have variable toxicity towards nematodes.. Many B. thuringiensis isolates have been found to be highly toxic to larval stages and adults of *Haemonchus contortus, Trichostrongylus colubriformis and Ostertegia circumcincta* in vitro Research on using *B. thuringiensis* to control the free-living larval stages of nematodes resulted in a significant reduction of existing parasites. These studies indicated that *B. thuringiensis* is toxic to both larval stages and adults of economically significant nematodes. Therefore, *B. thuringiensis* strains could be utilized as anthelmintic to kill nematodes of the gastrointestinal tract, and/or the free-living larval stages that develop in faeces or on pastures. On the other hand, *B. thuringiensis* spores are slow to germinate and develop crystal toxins to disturb the nematode growth (Grady *et al*., 2007). Notably freshly hatched larvae are more susceptible to *B. thuringiensis* toxins than older ones. These constraints limit the ability of *B. thuringiensis* isolates to inhibit nematode populations (Grady *et al*., 2007).

Earthworms

Feeds nematodes present in soil and faeces & actively participate in the destruction of eggs and larvae by digesting them or transferring them to deeper levels of the soil where chances that they can reach the surface as infective larvae are very low (Gronvold *et al*., 1996).

Dung Beetles

'Dung beetle' refers to those beetles that live partly or exclusively on the dung of herbivorous; most species belong to the family Scarabacidae.

Mites

Some mites are nematode predators. For example, some mites (Phytoseiid spp.) are capable of consuming *Ascaris ova* in the soil.

Control Of Intermediate Hosts

Lung worms like *Muellerius capillaris, Protostrongylus rufescens* exhibit indirect life cycle, snails or slugs acts as intermediate hosts biological control of the intermediate hosts by the use of natural enemies to control nematodes.

Use of ducks to reduce the snails by feeding them then use of fishes: certain fresh water fishes are known to feed on snails for example – *Pangasius pangasius, Osphromenus gourami*, etc. Birds,

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Large leeches, chaetogaster (annelid), certain insects and their larva acts as snail predators eg: the larvae fire flies and marsh flies are notorious.

Vegetative control by raising the plants *Balanites aegyptiaca* (Garapandu), *Acacia concinna* (Shikakai), *Caesalpinia coraria, Sapindus emerginatus* along the bank of ponds, fruits and seeds of these plants fall into pond and kills the snails which comes to bank.

Control of flies which acts as intermediate hosts for *Seteria, Onchocerca, Stephanofilaria. Spalangia cameroni* acts as pupal parasitoid *against stomoxys.* Entomopathogenic fungus like *Metarhizium anisopliae* acts *against Cuilicoides.*

Alternative dewormers

Herbal Dewormers

Phytomedicines in veterinary practice have great potential as alternative medicine Unlike synthetic anthelmintics, herbal medicines with different mode of action could be of value in preventing the development of the resistance (Singh *et al.*, 2008). Plant-based drugs are also believed to be less toxic to the host and end-users. They are easily available, biodegradable, cheaper and eco-friendly. Due to the important economic impact of GIN in the livestock industry around the world, most of the research on plant extracts is being focused on searching bioactive compounds from plants against this important group of parasites.

The most known cases of plants with nematocidal properties around the world are garlic (*Allium sativum*) Marigold (*Tagetes erecta*). *Fumaria parviflora* ethanol extract has eliminated faecal eggs and caused 72 and 88% mortality of adult *Haemonchus contortus* and *Trichostrongylus colubriformis*, respectively Extracts from Ivory Coast flora has exhibited nematocidal activity against *Haemonchus contortus* larvae. Extracts from *Croton macrostachyus* and *Ekebergia capensis* has In vitro anthelmintic activity against eggs and adult *H. contortus* (Mihretabs *et al*,.2011). Aqueous and ethanolic extracts of Adhatodavasica plant exhibits an in vitro ovicidal and larvicidal activity ranging between 81-89% against GIN of sheep.***Artemisia vulgaris*** has an active principle thujone which has an action against. *Haemonchus, Bunostomum, and Protostrongylus***. *Calotropis procera*** has an active principle called Aglycans which has an action against *Haemonchus contortus.* ***Butea monosperma*** has active principle Palasonine that acts against roundworms.

Diatomaceous Earth

DE is the fossilized remains of long – dead sea creatures, and are mined from ancient sea beads and ground to a fine, powder like consistency. It is believed that microscopic sharp edges of the DE particles scrape off the adult worms that have attached to the sheep's intestinal walls, so they can pass out with the faeces. The sheep get their DE in a ratio of about 1/4 DE

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and 3/4 salt-mineral mix.

Copper Sulphate

Copper sulphate is important for immune function in livestock.effective against certain internal parasites, notably barber's pole worm.

Conclusion

Looking into the present scenario as well as the future possibility, the herbal drug therapy may be considered as another promising option instead of chemical anthelmintics. None of the single control measures will give long term solution. Integration of more than one measure like good farming practices, best breeding strategies, appropriate biological control measures and alternate dewormers are essential to achieve the sustainable control on parasite

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