Use of medicinal plants to control *Haemonchus contortus* infection in small ruminants

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Abstract

Haemonchus contortus is singly the most important of all the gastrointestinal nematodes that constrain the survival and productivity of sheep and goats owned by rural poor farmers in the developing world. This haematophagus parasite is infamous throughout the humid tropics/subtropics, being responsible for acute disease outbreaks with high levels of mortalities, particularly in young animals. Costs associated with control of this parasite in India, have been estimated to be US$ 103 million. *H. contortus* is also prominent amongst the reports of anthelmintic resistance that has emerged in all countries of the world that produce small ruminants. This emergence of multiple anthelmintic resistances 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. This paper reviews the use of some medicinal plants as anthelmintics against H. contortus infection in small ruminants.

Keywords : Control, Gastro-intestinal parasitism, *Haemonchus contortus*, Medicinal plants, Small ruminants, Herbal antiparasitic, Ethnoveterinary

Introduction

Infections by gastrointestinal helminth parasites of livestock are among the common and economically important diseases of grazing livestock (Perry et al., 2002). Gastrointestinal parasites are world wide problem, manifested by reduced weight, lowered meat and milk production (Githigia et al., 2005). Furthermore, competition for the nutrients and tissue damage during feeding and migration could cause severe clinical signs such as anorexia, anaemia, diarrhoea and oedema associated with poor performance and mortality particularly in young, aged and immunosuppressed animals (Eysker and Pleoger, 2003). One exception to this is the highly pathogenic nematode parasite of ruminants, Haemonchus contortus, which is capable of causing acute disease and high mortality in all classes of livestock (Allonby and Urquhart, 1975). Consequently, there is an urgent and ever present need to control infections caused by H. contortus in ruminants.

Control is generally achieved by use of synthetic anthelmintics in combination with grazing management. The frequent use of these anthelmintics over many years has inevitably led to the development of drug resistance to each class in parasitic nematodes. *H. contortus* has been documented to be resistant to all three broad spectrum families of anthelmintics viz. benzimidazole, lmidazothiazole and ivermectin (Prichard, 1990; Singh et al., 2002) and against drugs with narrow spectrum of activity such as salicylanilides (Rolfe et al., 1990; Singh et al., 1996; Swarnkar et al., 1999).The emergence of resistance to anthelmintic drugs which is now a world wide phenomenon (Jackson and Coop, 2000) and the increased awareness of consumers about drug residues that potentially enter the food chain have stimulated investigation into alternative to commercially available anthelmintics such as medicinal plants.

For centuries, medicinal plants have been used to combat parasitism and in many parts of the world are still used for this purpose. The use of medicinal plants for the prevention and treatment of gastro-intestinal parasitism has its origin in ethnoveterinary medicine (Athansidou et al., 2007). In ethnoveterinary medicine, there seems to be a range of plants or plant extract suitable for treating almost every parasitic disease of livestock.

Anthelmintic activity of medicinal plants with particular reference to *Haemonchus contortus* infection.

Azadirachta indica (Neem)

The neem is known for its medicinal properties and has been recommended for use against gastro-intestinal nematodes and related problems in many parts of the world (Biswas et al., 2002; Subapriya and Nagini, 2005). In 1992, the National Research Council (NRC) of the United States considers the neem tree to be, "one of the most promising of all plants, that it may eventually benefit every person on this planet. Native to India, the Neem tree is widely planted and naturalized evergreen tree found throughout Asia. Preliminary studies showed that feeding Neem foliage is safe, eco-friendly, cheap and palatable to sheep. Ad libitum feeding of fresh Neem leaves produced 82% reduction in worm eggs of animals (Chandrawathani et al., 2000) and a further trial on a limited number of sheep showed that neem produced a significant reduction in worm burdens (Chandrawathani et al., 2002).

In another study, Chandrawathani et al. (2006) evaluated the anthelmintic effect of Neem (A. indica) on nematode parasites of sheep. Twelve Santa Ines cross bred sheep from a government farm were randomly selected and equally divided into control (n = 6) and treated groups (n =6). Faecal egg counts (FEC) using the modified McMaster technique and the FAMACHA score for assessing clinical anaemia were carried out daily and recorded for 6 weeks. At the end of the study, all the animals were slaughtered and the total worm count (TWC) was done. The results of FEC showed that there was no significant difference between the control and treated group ($p = 0.081$). However, worm burden estimations showed that the number of parasites was significantly higher in the control group compared to the treated group ($p < 0.05$). This result indicated that feeding neem had an effect on worm numbers in sheep. Most significantly, it is apparent that the highly pathogenic parasite, *H. contortus* appears particularly sensitive to the intake of fresh neem leaves by the animal.

Swarnkar et al. (2008a) have reported that when alcoholic extract of *A. indica* bark was evaluated in vitro for anthelmintic activity against pre-parasitic and parasitic stages of *H. contortus*, no anthelmintic activity was noticed. However, oral administration of alcoholic extract of A. indica bark (@ 50mg kg-1 body weight) was found to cause gradual reduction in faecal egg count in sheep infected with *H. contortus*. The corrected faecal egg count reductions on day 7 and 10 post treatment were 44.1 and 56.9% respectively, indicating the presence of moderate level of anthelmintic property in the extract.

Costa et al. (2008) conducted an in vitro test using ethyl and ethanol extracts of *A. indica* on *H. contortus* eggs and larvae. The ethanol extract was found to be more effective inhibiting larval development by 87.11% as compared to 68.10% by ethyl acetate extract at 50mg/ml. The ethanol extract inhibited egg hatching by 99.77% at 3.12mg/ml. These results suggest that A. indica extracts may be useful in the control of gastro-intestinal nematodes of small ruminants.

Butea frondosa (Palas)

Butea frondosa, popularly known as 'palas', is commonly distributed throughout India. Fruits and seeds of *B. frondosa* are reported to have anthelmintic property and largely used in treatment of round worms (Kirthikar and Basu, 1975). Active principle of seed is an alkaloid-palasonin. In various in vivo and in vitro studies, palasonin had been attributed to possess anthelmintic activity against adult *Toxocara canis* in dog, *Ascardia galli* in poultry and *H. contortus* in ruminants (Kumar et al., 1995; Jangde et al., 2001). The anthelmintic activity of palasonin was due to ability to inhibit glucose uptake and depiction of the glycogen content of worms, thus causing inhibition of energy metabolism (Kumar et al., 1995).

Swarnkar et al. (2008b) have reported that seed extracts of *B. frondosa* have potent embryonicidal (Chloroform and ether extract @ 1.25mg/ml), ovicidal (alcoholic extract @ 1.25mg/ml) and larvicidal (aqueous extract @20mg/ml) activity against exogenous stages of *H. contortus*. The in vitro assay used in the study measures the effect of extracts directly on physiological process viz. embryonic development, egg hatching and mortality and results suggest that possibly isolated bioactive compound from *B. frondosa* seeds could be a promising alternative to conventional anthelmintic for the treatment of gastrointestinal nematodes in the future.

***Allium sativum* (Garlick), *Zingiber officinale* (Ginger), *Curcurbita mexicana* (Kaddu) and *Ficus religiosa* (Pippal)**

Iqbal et al. (2001a) have reported that methanol extracts of *Allium sativum*, *Zingiber officinale*, *Curcurbita mexicana* and *Ficus religiosa*, all possess varying degree of in vitro anthelmintic activity. *Zingiber officinale* killed *H. contortus* worms within 2 hours (h) post exposure being 100% effective. *Allium sativum* and *Curcurbita mexicana* were equally effective at 2 and 4h post exposure, however, by 6 hour post exposure, *A. sativum* was 100% effective. Whereas C. mexicana could not kill all the worms and was found 83.4% effective this was not different from control. *F. religiosa* was 100% effective by 4h post exposure and was as good as *A.sativum* and *Z. officinale* by 6h post exposure. Oil of *A. sativum* has also been reported to possess anthelmintic activity (Perry, 1980) and discards all injurious parasites in the intestine (Nadkarni, 1976).

Crude powder (CP) and crude aqueous extract (CAE) of dried ginger (1–3 g/kg) were administered to sheep naturally infected with mixed species of gastrointestinal nematodes. Both CP and CAE exhibited a dose- and a time-dependent anthelmintic effect with respective maximum reduction of 25.6% and 66.6% in eggs per gram (EPG) of faeces on day 10 of post-treatment. This study shows that ginger possesses in vivo anthelmintic activity in sheep thus justifying the age-old traditional use of this plant in helminth infestation (Iqbal et al., 2006).

Coriandrum sativum (Coriander)

Eguale et al. (2007) investigated in vitro anthelmintic activities of crude aqueous and hydro-alcoholic extracts of the seeds of *Coriandrum sativum* (Apiaceae) on the egg and adult nematode parasite *H. contortus.* The aqueous extract of *C. sativum* was also investigated for in vivo anthelmintic activity in sheep infected with *H. contortus*. Both extract types of *C. sativum* inhibited hatching of eggs completely at a concentration less than 0.5 mg/ml. The hydro-alcoholic extract showed better in vitro activity against adult parasites than the aqueous one. For the in vivo study, 24 sheep artificially infected with *H. contortus* were randomly divided into four groups of six animals each. The first two groups were treated with crude aqueous extract of *C. sativum* at 0.45 and 0.9 g/kg dose levels, the third group with albendazole at 3.8 mg/kg and the last group was left untreated. Efficacy was tested by faecal egg count reduction (FECR) and total worm count reduction (TWCR). On day 2 post treatment, significant FECR was detected in groups treated with higher dose of C. sativum ($p < 0.05$) and albendazole ($p < 0.001$). On days 7 and 14 post treatment, significant FECR was not detected for both doses of *C. sativum* ($p > 0.05$). Significant ($p < 0.05$) TWCR was detected only for higher dose of *C. sativum* compared to the untreated group. Reduction in male worms was higher than female worms.

Sorghum bicolor (Sorghum)

Sorghum extracts delayed hatching and development of egg of *H. contortus* at lower concentrations and proved lethal at higher (>5-10%) concentrations (Iqbal et al., 2001b). The exact mechanism with which sorghum inhibited hatching and moulting of *H. contortus* eggs has not been so for investigated. However, it is speculated that allelochemicals of sorghum like benzoic acid, vanillic acid, p-coumaric acid, P-hydroxy benzoic acid changed the pH of the media which disturbed metabolic processes required for the hatching of eggs and moulting of larvae (Cheema, 1988). The inhibitory effects may have been mediated through ingestion of condensed tannins (like catechin, procyanidins, anthocynidin, leteoforol etc) of sorghum or due to the interactions of these tannins with the external surface of larvae of nematodes.

Vernonia amygdalina (bitter leaf) and Annona senegalensis (Custard tree)

Vernonia amygdalina and *Annona senegalensis*, two plants used by local/smallholder livestock farmers in Nigeria as anthelmintic were screened for in vitro anthelmintic activity using *H. contortus* eggs.The extract of *V. amygdalina* did not show any significant activity at concentrations up to 11.2 mg/ml. The extract of *A. senegalensis* showed significant ($P<0.001$) reduction in egg hatch at a concentration of 7.1 mg/ml. The in vitro faecal culture of eggs with A. senegalensis showed significant ($P<0.001$) reductions in larval recovery with increasing concentrations from 1 to 10% w/w in fecal culture when whole ground plant material was used. *A. senegalensis* showed promising anthelmintic activity especially with use of ground whole plant materials as used by some farmers (Alawa et al., 2003).

Conclusion

Since the last decade, the number of studies dedicated to the scientific validation of the antiparasitic effects of plants has shown an exponential growth. For some plant products, like condensed tannins, evidences have accumulated indicating that plants whose AH properties have been to some extent scientifically validated, might represent a valuable solution within the "basket of options" to achieve a more sustainable control of gastro-intestinal nematodes with a reduced reliance on chemical anthelmintics (Krecek & Waller, 2006). A holisitic approach supported by the participation of specialists from a large range of scientific fields is highly desirable to help small farmers to contain nematode parasite infections in sheep and goats by relying on natural resources.

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