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Use of Plant Anthelmintics as an Alternative Control of Helminthic Infections in Sheep

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Abstract

The performance and productivity of sheep is adversely affected by helminthic infections. The control of helminth infections has always been a challenge. Till now, the main control methods of these infections are treatments with broad spectrum synthetic anthelmintics like ivermectin, albendazole, levamisole, etc. However, the drug residues in animal products and the development of anthelmintic resistance has restricted their usage in animals. Recent research shows that plant natural compounds and products (herbal anthelmintics) offer an environmentally safe and a sustainable alternative to them. Various active anthelmintic molecules have been purified from various plant sources, these include: Atanine, Santonin, Phenantherenes, Eugenol, Palasonin, Santovin, Alantalactone, Benzoquinone, Tetra-hydroharmine, Anthraquinone, Kestoxin, Ascaridole, Azadirachtin, Bromclain, Allicin, Kaurenoic acid, Anthocyanin, etc. These natural compounds are more stable, have greater structural diversity than synthetic ones and, therefore, are active against a wide range of target parasites. This diversity can preclude the occurrence of anthelmintic resistance, therefore, they are a good and reliable alternative to traditional drugs for the successful control of helminth parasites.

Keywords

Helminth parasites; Anthelmintic resistance; Herbal anthelmintics; Control

Introduction

Various species of helminthes parasitize sheep and result in considerable pathogenesis and economic losses in sheep farming. Some of the important helminth parasites of sheep are: *Fasciola hepatica, Paramphistomum* spp. *Haemonchus contortus, Trichostrongylus axei, Trichostrongylus colubriformis, Bunostomum trigonocephalum, Chabertia ovina, Nematodirus spathiger, Skrjabinema ovis, Trichuris ovis, Moniezia expansa, Stilesia* spp. etc. These parasitic helminthes particularly *Haemonchus*, *Bunostomum* and *Fasciola* are a major constraint worldwide and impact food security and incomes through their deleterious influences on sheep productivity. The problem to control these infections is further complicated due to the emergence of anthelmintic resistance (AR) against the chemical anthelmintics (CA). AR is defined as a decrease in the efficacy of an anthelmintic against a population of parasites that is generally susceptible to that drug. The environmental change in terms of global climate warming has further aggravated the situation due to the emergence and re-emergence of helminth diseases in sheep. As a consequence the effective management of helminth diseases has become an alarming problem in sheep industry. The option of herbal anthelmintics (HA) has provided an important and viable alternative to control and treat these helminthic infections [1]. Further, the herbal anthelmintics can be explored in reversing the AR against some of the conventional drugs in the market.

Tests for screening the anthelmintic activity of plant based extracts and drugs

The tests performed for screening the anthelmintic efficacy of herbal extracts are generally based on *in vitro* and *in vivo* methods already established by several workers. The *in vitro* tests have been used as preliminary studies using parasitic nematodes and offered a means of evaluating the anthelmintic activity of new plant compounds Tariq et al. [2]. Some of the important *in vitro* tests utilized are *worm mortality assay*, *worm motility inhibition assay*, *egg hatch inhibition assay*, *larval mortality assay*, *larval development assay*, *larval migration assay*. The main advantages of using *in vitro* assays to test the herbal anthelmintics are the low costs and rapid turnover which allows large scale screening of plants/plant products.

The most significant *in vivo* test to screen plant extracts and products is *faecal egg count reduction test*. However, in *vivo* tests are not considered the best model for anthelmintic activity since, these tests are time consuming, expensive and present low precision and reproducibility due to inter animal variation and pharmacodynamics of the drug in the host Craven et al. [3]. In most cases, the active material has to be extracted from the plant and under *in vitro* conditions the concentrations used are not always comparable to those *in vivo*, and thus often the results can differ in the two assays Athanasiadou et al. [4]. Considerable physiological differences present between the *in vitro* conditions and in the predilection site of the parasite within their animal hosts (*in vivo*), including factors within hosts effect bioavailability of the active compounds. Therefore, *in vitro* tests are mainly used in the pharmaceutical industry and are valuable for initial screening and to establish biologically realistic drug concentrations for further testing in the animal models and actual host.

The physiology and resistant status of a parasite plays a significant role in evaluating the anthelmintic efficacy of the HA and there is the possibility that herbal extracts may be affecting some parasites and not others in mixed infection. Obviously previous research has shown that some HA were quite active against one parasite species infection but could not pose any effect against mixed infection of gastrointestinal nematodes in sheep Felix et al. [5]. For example, Muraleedharan et al. [6] observed reduction in faecal egg count in *H. contortus* of goats on day 14 post treatment of Neemrich 180-EC, an oil based product extracted from neem (*Azadirachta indica*) seeds. However, Costa et al. [7] reported that leaves of *Azadirachta indica* had no anthelmintic effect against mixed gastrointestinal nematodes of sheep. Therefore, further studies are required to solve these issues confronting the use of HA as an option towards to the control of helminthoses in sheep.

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Anthelmintic molecules from plants-are they a reliable choice

The main methods that are presently used to control helminth diseases in sheep are based on CA. But due to the emergence of anthelmintic resistant parasites in sheep, there is a need for the evaluation of other alternative strategies to develop sustainable, effective and safe alternatives to conventional anthelmintics-the concept of HA. Different strategies like ethno-veterinary medicine have already been used and should be further developed to determine a practical basis for the selection of plants for scientific examination of their anthelminthic properties and development of new plant based anthelmintic drugs. Two potential hypotheses have been put forward to account for the reduction of the parasitism in animals treated with HA. The first hypothesis views that the anthelmintic action could be either due to direct toxic effects (affecting larval establishment, larval motility and mortality, decreasing faecal egg output, impairing worm development, and decreasing egg hatchability from faeces paralysis and ultimately death of worms) on the worms. The indirect mode of anthelmintic action could be due to changes in the gut environment (gastrointestinal irritation) that favour low fecundity and worm expulsion, and balancing antioxidant blood levels, improving the nutritional status (protein availability), and boosting the immune system of parasitized animals [8].

In a number of studies, the active molecules showing anthelmintic properties against a wide variety of helminth parasites of sheep have been purified and characterized from plant extracts Githiori, [9]. For example, Atanine, a quinolone alkaloid isolated from *Evodia rutaecarpa* dried fruits was found to inhibit the motility of larvae of *Teladorsagia* (*Ostertagia*) *circumcincta*. Flavan-3-ols (the monomer units of CT) was found to have an effect on egg hatching as well as the development of larvae of *T. colubriformis*. Alkaloids and Glycosides from roots of *Adhatoda vesica* and Resin, Tannins and Alkaloids from *Nauclea latifolia* bark were found effective against mixed nematode infections in sheep. Diterpenoids from *Annona senegalensis* bark and Ascaridole from *C. ambrosioides* leaves and seeds were found also active against eggs of H. *contortus*. Azadirachtin from seeds of *Azadirachta indica* was found active against nematode infections of sheep and goats. Bromclain from leaves of *Ananas comosus* showed efficacy against nematode infections of sheep. Kaurenoic acid from bark of *Annona glabra* has been found effective against adult *H. contortus* of sheep. Anthocyanin, Alkaloids and Resins from *Calotropis procera* latex and D-3-O-methyl chiroinositol from bark of *Piliostigma thonningii* were found effective against L_3 larvae of *H. contortus*. These anthelmintic agents from plants are, therefore, effective means of control and have the potential to decrease the level and incidence of helminthic infection in sheep.

Conclusion

The natural compounds derived from plants are more stable and provide greater structural diversity than synthetic ones and are a source of low molecular weight structures active against a wide range of target agents and this diversity can preclude the occurrence of anthelmintic resistance Mishra et al. [10]. However, simultaneously HA will generate new selection pressure/s for the parasitic organisms to develop resistance within a parasite population Tariq [11]. Therefore, we cannot break the selection process of resistance but we can delay it by providing alternate products in reliable and standardized doses in replacement to conventional drugs Tariq [11]. Plant natural products are a promising alternative in this direction and have in several cases shown good anthelmintic effects against parasites of sheep as discussed above. Therefore, nematode management with emphasis on use of herbal anthelmintics will be quite useful for the successful control of many parasites.

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