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Prospects of botanical dewormers with especial reference to Kashmir

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Abstract
The increasing prevalence of anthelmintic resistant strains of helminth parasites, drug residues in animal products and high cost of marketed anthelmintics has enhanced an attention in studying medicinal plants as an alternative source of anthelmintics. Alkaloids, alpha-pinene, artemisin, benzyl isothiocynate, Cucurbitacin, dithymoquinone, genistein, papain, phenolic compound, tannin and thymoquinone are some active constituents found in different plants and act against the helminth parasites of animals and human beings. Mostly the tannin-rich forages offer an alternative to anthelmintic chemicals in controlling gastrointestinal nematodes. The traditional use of different plants showing the anthelmintic activities against various endoparasites of animals in different regions of country with special reference to the Kashmir valley are reviewed in this communication.

Keywords: Carcass characteristics, weaner pigs, meat quality, palm kernel cake

Introduction
India possesses largest livestock population in the world which plays an important role in Indian economy. The livestock sector has a major significance in the rural economy of Jammu and Kashmir contributing 5.04% to the state GDP [1]. Despite the great contribution of livestock sector to the economy and livelihood of the people of Kashmir valley it is further aggravated by various bacterial, viral and parasitic diseases. Parasitic diseases are considered to be the most prevalent and important health problems in grazing ruminants inflicting losses through mortality, feed efficiency ratio and by way of costs incurred upon their treatment and control [2]. Amongst the helminth parasites, gastrointestinal (GI) parasite infected animals have lower growth rates, reduced reproductive performance, and have higher rates of illness and death. Therefore anti-parasitic drugs are used to control the parasitic diseases. An ideal anthelmintic drug should have broad spectrum of action, high cure rate with single dose, free from toxicity to the host and also cost effective. But, no synthetic anthelmintic agent meets all requirements. Ethno-veterinary practices can be used as sustainable development through appreciating and building upon local knowledge of veterinary and husbandry practices. In this way, herbal medicine may very well become a pioneer in turning local knowledge into global knowledge, through the recognition of local knowledge as an indispensable source of sustainable development for both people and animals all over the world. Traditional veterinary medicine has been practised as early as 1800 B.C. at the time of king Hammurabi of Babylon [3]. Therefore, switch to ethno-veterinary drugs is based on the cultural heritage of an area that involves interaction between plants and the people including the traditional use of medicinal plants and their management is referred as ethnobotany [4]. A plant with therapeutic properties naturally synthesise and accumulates some secondary metabolites like alkaloids, volatile oils, vitamins and minerals in different parts such as leaves, fruits, seeds and rhizomes [5, 6] and play a significant role in providing health care and improving economy of the farmers [7]. Satyavati *et al.* [8] reported the plant kingdom is known to provide a rich source of botanical anthelmintics, anti-bacterial and insecticides. A number of medicinal plants have been used to treat parasitic infections in man and animals. There are many plants which have been reported in the literature for their anthelmintic importance. A number of studies have been carried out showing that certain plant species have the nutritional value but also show promising results in reducing the parasitic infection in sheep [9, 10].

Traditional use of plants against parasitic infections in human beings as well as livestock is common practice in Kashmir valley. A number of compounds have been identified which show promising anti parasitic activity. Some of them are discussed below.

Alkaloids

Alkaloids present in different plants used against different helminth parasites may act on central nervous system and cause paralysis of the helminthes. Steroidal alkaloid and oligoglycosides are present in alkaloids which may suppress the transfer of sucrose from the stomach to the small intestine. Alkaloids also act as an antioxidant, capable of reducing the nitrate generation which can interfere in local homeostasis that is essential for the development of helminths [11].

Phenolic compound

Phenolic compounds present in different parts of different plants when administered against endoparasites interfere with the energy generation mechanism by uncoupling the oxidative phosphorylation and also interfere with the glycoproteins of the cell surface of the parasites and cause their death [12].

Tannins

Various pasture tanniferous plants have been investigated for potential effect against either incoming parasite larvae and/or already established worms [13]. Tannins interfere with energy generation of worms by uncoupling oxidative phosphorylation or they binds to the free proteins of the gastrointestinal tract of the host animal or glycoproteins on the cuticles of the worms and lead to death [14]. The beneficial effects of tanniferous plants against internal parasites could be due to one, or a combination, of the following factors:

1. Tanniferous plants increase the supply and absorption of digestible protein by animals. This is achieved by tannins forming non-biodegradable complexes with protein in the rumen, which dissociate at low pH in the abomasum to release more protein for metabolism in the small intestine of ruminants. This indirectly improves host resistance and resilience to nematode parasite infections [15].
2. Tannins have a direct anthelmintic effect on resident worm populations in animals [15].
3. Tannins and/or their metabolites in dung have a direct effect on the viability of the free-living stages (development of eggs to infective larval stages).

These plants can be a promising future for the control of worms which had previously shown resistance to synthetic drugs. These plants can be used to feed animals not only as source of nutrition but also as a source of certain antiphrastic substances. It is well known that tannins can produce this effect; however, similar results can be obtained with a variety of other substances. Tannins are usually divided into hydrolysable and condensed tannins (CT), although there are other types.

Condensed tannins, the most frequent type of tannins found in leguminous plants and trees are relatively stable in the digestive tract of the animals and they rarely have toxic effects and can therefore, used to control parasite populations. CT are a diverse group of plant secondary metabolites usually found in leaves, roots, nuts and fruits from a wide-range of different plant sources in both tropical and temperate areas [16]. Tannins used in different concentrations (5-50% of DM) in animal diets can reduce the parasitic population. CTs have antimicrobial properties also [17]. Besides this, they have effect on *Candida albicans* [18], *Trypanosoma brucei* [19] and *Leishmania donovani* [20]

In addition, a number of studies conducted with nematode parasites of ruminants have demonstrated direct anthelmintic effects of extracts from tannin-containing plants in *in vitro* assays, with *in vivo* verification of these results being reported in some studies [21]. *Haemonchus contortus* infections in livestock have been found to be influenced by tannin structure [22] obtained from the diverse nature of CT in different plant sources. It was found that extracts of tannin-rich plants interfere with the first phase of host invasion, i.e., the exsheathment of infective third stage larvae [22].

Tannins have both direct and indirect effects over the gastrointestinal parasites in ruminants [15].

i. Direct effects: caused by the tannin-parasite interaction, affecting the parasite's physiology.
ii. Tannins extracted from several forages reduce the total nematode burden, the migration, the viability of the larvae and the egg per gram (EPG) count.
iii. They can also interfere with the hatching of the eggs and the development of infective larval stages.
iv. CT of *Quebracho* had a direct anthelmintic effect against *Trichostrongylus colubriformis* infection in sheep.
v. The administration of quebracho extract reduces the EPG count, the adult burden and the fecundity of *T. colubriformis*.
vi. Indirectly, tannins improve the protein nutrition by binding themselves to the proteins of the plants in the rumen and preventing the microbial degradation, thus increasing the offer of amino acids to the duodenum.
vii. Recent experiments suggest that the addition of *quebracho* tannins to diets with low protein levels can improve the diet quality and reduce the consequences of parasitism.

Among the most common medicinal plants which have anthelmintic effect are

- *Allium sativum,* (garlic)
- *Nigella sativa,* (Kalonji, black cumin/ black caraway)
- *Artemisia* spp., (tethwan)
- *Balanites aegyptiaca,* (desert date or Azores)
- *Acacia* spp., (babul, kikar or Indian gum Arabic tree)
- *Cucurbita pepo* (pumpkin seeds),
- *Commiphora molmol* (Myrrh),
- *Calendula micrantha officinalis,* (marigold)
- *Peganum harmala* (Harmal/ Isband) and
- *Curcuma longa* (Tumeric) [23, 24]
- *Achillea millefolium* (Pahel gassa) Crude aqueous and ethanolic extracts have anthelmintic activity in sheep infected with mixed species of gastrointesinal nematodes

Table 1: Medicinal plants used against helminth parasites of animals

Plant	Part used	Active constituent	Indication cited or activity	Animal species	Reference
Acacia albida	Seeds		Worm infestation	Sheep, goat	Nwude and Ibrahim [25]
Langium lamarckii	Root-bark		*Ascarids*	Poultry	Dubey and Gupta[26]
Albizia anthelmintica	Bark Root		Fasciolosis, lungworms	Cattle, goat, sheep,camel	Minja [27]; ITDG and IIRR [28]
Albizia coriavera *Allium sativum*	Bark Bulb		Fasciolosis, lungworms Roundworms	Cattle, goat, sheep.	ITDG and IIRR [28]
Aloe barteri	Leaves	Anthraquinone	*Nippostrongylus braziliensis*	Rat	Ibrahim *et al*. [29]
Ananas comosus	Fruit		*Ascaridia galli*	Chicken	Fernandez [30]
Annona cherimolia *A. muricata braziliensis*		Acetogenins	*Nippostrongylus*	Rat	Bories *et al*. [31]
A. senegalensis	Leaf, bark, root	Anthraquinone	*Nippostrongylus braziliensis*	Rat	Ibrahim *et al*. [29]
Anogeissus leiocarpus	Bark, seed	Anthraquinone	*Nippostrongylus braziliensis*	Rat	Ibrahim *et al*. [29]
Areca catechu	Nut	Arecolin, other alkaloids	Taenicidal	Cattle, goat, dog	Roepke [32]
Artemisia maritima		Santonin, Artemisin	*Neoascaris vitulorum*	Buffalo calves	Akhtar *et al*. [33]; Farnsworth *et al*. [34]; Sherif *et al*. [35]
Bixa orellana	Seeds		*Ascaridia galli, Ascaris suum*	Chicken, Pig	Fernandez [30]
Boswellia dalzelii	Bark		Anthelmintic	Sheep, goat	Nwude and Ibrahim [25]
Butea frondosa			*Oxyurids,* *Ascaridia galli*	Mice *In vitro*	Mehta and Parashar [36] Lal *et al*. [37]
Caesalpina crista	Seeds		*Toxocara vitulorum, Ascaridia galli*	Buffalo calves, chicken	Akhtar et al. [38]
Callindra portoricensis	Root		*Toxocara canis*	Dog	Adewunmi and Akubue [39]
Carica papaya	Latex from fruit		*Ascaridia galli, Ascaris suum, Heligmosomoides polygyrus*	Chicken, Pig, Mice	Mursof and He [40]; Satrija *et al*. [41]; Satrija *et al*. [42]
Carissa edulis	Root		Roundworms	Cattle, goat, sheep	ITDG and IIRR [28]
Cassia alata	Seeds		*Ascaridia galli*	Chicken	Fernandez [30]
Chrysanthemum spp.		Pyrethrin	*Ascaridia lineata*	Chicken	Rebrassier [43]
Diospyros mollis		Diospyrol	*Necator americanus, Nematodirus dubius, Hymenolepis nana*	Mice, Golden hamster	Sen *et al*. [44]
Mangifera indica	Seeds		*Ascaridia galli*	Chicken	Fernandez [30]
Mimosa pudica	Stem		*Haemonchus contortus*		Fernandez [30]
Peganum harmala	Seeds	Tetra-hydro- harmin	Mixed gastro-intestinal infection	Goat	Akhtar and Ahmad [23]
Quisqualis indica	Stem		*Ascaris suum, Ascaridia galli*	Pig Chicken	Fernandez [30] Farnsworth *et al*. [34]
Rapanea melanoploeos	Seeds		Roundworms	Cattle, goat, sheep	ITDG and IIRR [28]
Rhus vulgaris	Root		Roundworms	Cattle, goat, sheep	ITDG and IIRR [28]
Tamarindus indica	Root		Roundworms	Cattle, goat, sheep	ITDG and IIRR [28]
Terminalia avicennoides	Leaf, root	Anthraquinone	*Nippostrongylus braziliensis*	Rat	Ibrahim et al. [29]
Tiinospora rumphii	Stem		*Haemonchus contortus*	Goat	Fernandez [30]
Tribulus terestris	Plant		*Ascaridia galli*	Poultry	Chakraborty *et al*. [45]
Uvaria hookeri	Root-bark	Acetogenins	*Haemonchus contortus*		Padmaja *et al*. [46]
Vernonia anthelmintica			*Oxyurids*	Mice	Mehta and Parashar [47]

***Commiphora molmol* (Myrrh)**

Myrrh, an oleo-gum resin obtained from the stem of the plant species of genus *Commiphora* (*C. molmol*) used as safe effective treatment for dicrocoelosis in sheep (Al-Mathal and Fouad, 2004) [48]. Myrrh used against schistosomosis in human beings showed that the drug was well tolerated, and side effects were mild and transient [49, 50]. Consequently, Myrrh extract of the medicinal plant, *C. molmol* proved to be safe and very effective in sheep monieziosis caused by *Moniezia expansa* [51].

***Ocimum sanctum* Linn. (Babri seeds)**

It's also known as sacred basil. The essential oil contains eugenol, B-caryophllene and other monoterpenes in the plants which showed potent *in-vitro* anthelmintic activity [52, 53].

***Melia azedarach* (commonly known as the chinaberry tree)**

Ethanolic extract of chinaberry, the plant which is native to India, China and Paris were found to act against tapeworms. Szewezuk *et al*. [54] found more efficacy of ethanolic extract of the plants as compare to piperazine phosphate.

***Artemisia annua* (Tethwan)**

It is also known as sweet wormwood, sweet annie, sweet sagewort which contains artemisin. Cumming *et al*. [55] reported that artemisinin damaged biological macromolecules of the parasites by causing oxidative stress in the cells; it is done by cleavage of endoperoxide bridges by iron producing free radicals (hypervalent iron-oxo species, epoxides, aldehydes and dicarbonyl compounds). Hence, the artemisin, the active compound of this tree may be used as plant dewormer against some internal parasites of animals [56]. Artemether, a methyl ether derivative has proven efficacy against *Schistosoma haematobium*, *S. Japonicum* and *S. mansoni* [57].

***Carica papaya* Linn**.

Papain and Benzylisothiocynate is the active principles of papaya which effect against helminth parasites of animals and human beings. Among these, benzyl isothiocyanate which inhibits energy metabolism and affects motor activity of the parasites, hence acts as an anthelmintic agent [58]. Ethanolic extract of papaya were found effective against *Paramphistomum cervi*, *H. contortus*, *Ascaris lumbricoides* and *Ascaridia galli* [57, 59]. While papain, also known as papaya proteinase I, is a cysteine protease enzyme present in leaves, fruits, and seed of papaya (*C. papaya*) and mountain papaya (*Vasconcellea pubescens*). Papain consists of a single polypeptide chain with 3 disulphide bridges and a sulfhydryl group necessary for activity of the enzyme which is responsible for digestion of nematodes cuticle.

***Nigella sativa* (kala jira)**

Along with anthelmintic property it has digestive, carminative, diuretic and astringent activities. The active ingredients of kala jira are thymoquinone, dithymoquinone and alpha- pinene as ingredients. *N. sativa* and its essential oil have anthelmintic action against trematodes, nematodes and cestodes [60, 61]. Black seeds of *N. sativa* induce oxidative stress against mature worms which was revealed by declining activities of antioxidant enzymes, glutathione peroxidase, glutathione reductase and superoxide dismutase as well as hexokinase and glucose-6-phosphate dehydrogenase, the glucose metabolism enzymes [62]. This plays a key role in the control of the overgrowth of helminthes [63]. *N. sativa* oil exhibits an additive effect in the treatment of schistosomiasis when it is given with praziquantel.

Flemingia vestita (Fabaceae) and ***Moghania vestita*** **(baker) syn:** *Flemingia procumbens*

The white root tubers of baker, a leguminous root crop are eaten raw which act as a putative anthelmithic against intestinal parasites. Genistein an active ingredient successfully tested against various trematodes and nematodes has shown good results [64]. Genistein, the major active components which occurs in the edible root-tuber peel of *Flemingia vestita* showed a vermifugal/vermicidal effect on cestodes *in vitro* by causing a flaccid paralysis and alterations in the tegumental architecture and activity of several enzymes associated with the tegumental interface of the parasites [64]. Tandon *et al*. [65] reported that genistein obtained from crude extract of baker may influence the glycogen metabolism of *Raillietina echinobothridia*.

Cucurbita pepo **(Pumpkin)**

The pumpkin seeds contain several major groups of active constituents *viz*. essential fatty acid**s,** amino acids, mucilaginous carbohydrates, phytosterols, minerals and vitamins [49, 66]. Cucurbitacin is a constituent in pumpkin seeds that has shown anti-parasitic activity. Pumpkin seeds have purported effects against tapeworms [66].The seeds have been shown to effectively treat acute Schistosomiasis in our neighbouring country China.

Juglans nigra **(black walnut) &** ***Tanacetum vulgare*** **(Tansy)**

Black walnut and tansy used particularly in treating nematodes infestation especially enterobiosis caused by *Enterobius vermicularis*, a cosmopolitan parasite (Mali and Mehta, 2008) [57]. Presence of tannins, flavonoids and polyphenolic compounds in black walnuts produce anthelmintic activities [67]. The oil of tansy contains tannins and thujone which act against *Nematodirous* spp.

Mimusops elengi

An evergreen tree found in the south Asia and Northern Australia commonly known as Spanish cherry, bulletwood. This plant is used as non-astringent, cardiotonoic, stomachic and anthelmintic. Tannins of this plant cause uncoupling of oxidative phosphorylation. Stem bark has antihelmintic property [68]. It also contains taraxerol and taraxerone. Bark, flowers and fruits are used in ayurvedic medicine as anthelmintic. Alcoholic extracts showed some efficacy against round worm (*Ascardia galli*) in laboratory studies.

Punica granatum **(Anar)**

Root and stem of the plant is used as an astringent and anthelmintic. Ethanolic extracts of the plant are used in treatment of paramphistomosis in infected sheep. It inhibits transformation of egg to larvae of *Haemonchus contortus*. It also shows efficacy against nematodosis. The stem bark is reported to contain an alkaloid, Pelletierine [69, 70].

Thymus vulgaris

Thymus vulgaris is a species of flowering plant belong to mint family. Thymol an important component has antihelmintic property against *H. contortus*. It shows great efficacy in treating hookworm infection at the dose rate of 2-3 ml extract three times a day [71].

Kashmir perspective:

There is an increasing importance in old-fashioned uses of plants for health care among different communities especially in developing countries like India, Pakistan, Nepal, Bangladesh, Sri Lanka etc. Kashmir valley is located in 32°17´ to 36°58´N latitude and 73°26´ to 80°30´ E longitude and an altitude of 1730 m above sea level with Agro-climatic zone of north-west temperate Himalayan region of India having diverse variety of medicinal flora. The traditional uses of different plants against parasitic infections or infestations in both human and livestock is a common practice in the valley. Most of the rural people used the medicinal herbs or plants as veterinary drugs due the expensiveness of the chemical anthelmintics. Based on well-structured questionnaire and detail discussions Tariq and Tantry[72] claimed that 44 plant species belong to 37 genera and 26 families are used as the traditional anthelmintics in different preparation and forms which had the anthelmintic properties. Out of these plants, *Artemisia absinthium* (tethwen) and *Achillea millifolium* (pahel-ghassa) were scientifically validated for their claimed anthelmintic action against naturally infected gastrointestinal nematodosis in sheep of the valley [73, 74].

The complete cessation of motility of *Bunostomum trigonocephalum*, the hook worms of sheep after administration of crude aqueous extracts of *Allium sativum* (Rohun) was observed by Khobragade *et al*. [75] in the valley**.** Tetrahydro-harmin, the active constituent found in seeds of *Preganum harmala* **(**Isband**)** was found as effective against mixed gastrointestinal nematode infection in goats [23]. The leaves and flowering tops of *Artimisia absinthium* **(**tethwan**)** contain volatile oil rich in thujone which has been reported to treat infections with nematodes [76]. Lourenco *et al*. [77] reported that crude aqueous and ethanolic extracts of *Achillea millefolium* (Pahel-gassa) showed significant anthemintic activity against naturally infected sheep with mixed GI nematodes species. Eugenol, an extract of Rong has also been confirmed to possess anthelmintic activity [53]. Crude powder and crude aqueous extract of *Zingiber officinale* **(**Adrak**)** has exhibited anthelmintic activity against gastrointestinal nematodes of sheep [78]. The oral administration of the crude aqueous extracts of *Artemisia absinthium* in sheep was associated with significant reduction in faecal egg output by the GI nematodes [73]. *Chenopodium ambrosioides* **(**Ganhar**)** has been reported to cause paralysis and death of worms [72]. *Punica granatum* **(**Daein**)** and Cucurbita spp. (Aal) have been exclusively employed to treat parasitism due to *Taenia saginata* [72]. Wagay [79] in his study from north Kashmir has identified some plants with anthelmintic activity *viz*. *Angelica glauca* (Chora/frin), whole plant extract of *Cardamine macrophylla* (Pahal laish), oil of *Chenopodium urbicum* (Zewa Dawda Kual), seeds of *Portulaca oleracea* (Nunner), leaf extract or paste of *Prunus persica* **(**Chinan**)**, whole herb extract of *Verbena officinalis* **(**Hutmool**)** etc. In Kashmir

valley, Tariq and Tantry [72] conducted a study to observe the anthelmintic properties of some plants and found that root and stem bark of *Acacia arabica* (Kekar), leaf of *Cannabis sativa* **(**Bangh**)**, seeds of *Datura stramonium* **(**Dattur**)**, roots of *Daucus carrota* **(**Gazzer**)**, aerial parts of *Euphorbia royleana* (Guir sochel), fruit and bark of *Ficus carica* **(**Anjeer**)**, bark and leaf of *Juglans regia* (Doon), whole plant of *Nelumbo nucifera* (Pamposh), whole plant of *Nepeta cataria* (Soi), seeds of *Ocimum basilicum* (Babri byol), root and stem bark of *Prunella vulgaris* (Kalaveuth), roots of *Raphanus sativus* (Muj) etc. showed the anthelmintic properties.

Conclusion

The advantages of studying local knowledge of herbal medicine are numerous and most of them have already been outlined here. To sum up, it is important, in both a socioeconomic and a scientific perspective, to draw upon the rich store of ethnomedicinal knowledge. The herbal anthelmintics offer cheaper, more sustainable, available, reliable and familiar alternatives to imported synthetic drugs. Furthermore, when put into production locally, they can reinforce the income and status of local inhabitants. The recognition and development of herbal dewormers offers treatment methods that are more environmentally benign, since they tend to be less toxic, produce fewer unanticipated side-effects, are more biodegradable, accumulate no drug residues in meat or faeces and apparently do not trigger anthelmintic chemoresistance. However, there are problems connected with the use of botanical dewormer, the largest being the lack of scientific evaluation. Ethnobotanical approach, the most effective knowledge assumes that indigenous uses of plants indicate the presence of biologically active constituents in the plants. This is a slow but very urgent process, as young people desert the traditional knowledge and lifestyles of their elders, leading to the possible disappearance of this knowledge.

References

1. Anonymous. Annual Report, Department of Animal Husbandry Dairy and Fisheries. Ministry of agriculture and Farmers Welfare Government of India 2019, 1-192, http://dahd.nic.in/documents/reports.
2. Shahardar RA. A hand book of common parasitic diseases of the livestock for field veterinarians. (First Edition), IBDC publishers, Lucknow, India 2013.
3. Veen STW. Sense or nonsense? Traditional methods of animal disease prevention and control in the African savannah. Ethnoveterinary Research and Development. Intermediate Technology Publications, London 1996, 25-36.
4. Gaikwad J, Wilson PD, Ranganathan S. Ecological niche modelling of customary medicinal plant species used by Australian Aborigines to identify species-rich and culturally valuable areas for conservation. Ecological Modelling 2011;222:3437-3443.
5. Ahmad M, Khan MA, Rashid U, Zafar M, Arshad M, Sultana S. Quality assurance of herbal drug valerian by chemotaxonomic markers. African Journal of Biotechnology 2009;8:1148-1154.
6. Madhu CS, Saradha AC. Evaluation of Haemagglutination and anti-cancer potential from Indian dietary plants. International Journal of Pharmacy and Pharmaceutical Sciences 2018;10:105-108.
7. Shinwari ZK, Gilani SS. Sustainable harvest of medicinal plants at Bulashbar Nullah, Astore (northern Pakistan). Journal of Ethnopharmacology 2003;84:289-298.
8. Satyavati GV, Raina MK, Sharma M. Medicinal Plants of India. Indian Council of Medical Research, New Delhi 1976;1:201-206.
9. Githiori JB, Höglund J, Waller PJ, Baker RL. Anthelmintic activity of preparations derived from *Myrsine africana* and *Rapanea melanophloeos* against the nematode parasite, *Haemonchus contortus* of sheep. Journal of Ethnopharmacology 2002;80:187-191.
10. Waghorn GC, McNabb WC. Consequences of plant phenolic compounds for productivity and health of ruminants. Proceedings of the Nutrition Society 2003;62:383-392.
11. Roy H, Chakraborty A, Bhanja S, Nayak BS, Mishra SR, Ellaiah P. Preliminary phytochemical investigation and anthelmintic activity of *Acanthospermum hispidum* DC. Journal of Pharmacological Sciences and Technology 2010;2(5):217-221.
12. John J, Mehta A, Shukla S, Mehta P. A report on anthelmintic activity of *Cassia tora* leaves. Journal of Science and Technology 2009;31(3):269-271.
13. Niezen JH, Waghorn GC, Charleston WAG. Establishment and fecundity of *Ostertagia circumcincta* and *Trichostrongylus colubriformis* in lambs fed lotus (*Lotus pedunculatus*) or perennial ryegrass (*Lolium perenne*). Veterinary Parasitology 1998;78:13-21.
14. Patel J, Kumar GS, Qureshi MS, Jena PK. Anthelmintic activity of ethanolic extract of whole plant of *Eupatorium odoratum*. International Journal of Phytomedicine 2010;2:127-132.
15. Ahmad HA, Bulbul, KH, Akand AH, Ahmed N. Herbal dewormer: a way and mean to combat anthelmintic resistance. North-east Veterinarian 2018;18(1):11-14.
16. Jansman AJM. Tannins in feedstuffs for simple-stomached animals. Nutrition Research Reviews 1993;6:209-236.
17. Cowan MM. Plant products as antimicrobial agents. Clinical Microbiology Reviews 1999;12:564-582.
18. Ishida K, de Mello JCP, Cortez DAG, Filho BPD, Ueda-Nakamura T, Nakamura CV *et al*. Influence of tannins from *Stryphnodendron adstringens* on growth and virulence factors of *Candida albicans*. Journal of Antimicrobial Chemotherapy 2006;58:942-949.
19. Kubata BK, Nagamune K, Murakami N, Merkel P, Kabututu Z, Martin SK, *et al. Kola acuminata* proanthocyanidins: a class of anti-trypanosomal compounds effective against *Trypanosoma brucei*. International Journal for Parasitology 2005;35:91-103.
20. Kolodziej H, Kiderlen AF. Antileishmanial activity and immune modulatory effects of tannins and related compounds on *Leishmania* parasitised RAW 264.7 cells. Phytochemistry 2005;66:2056-2071.
21. Hoste H, Martinez-Ortiz-De-Montellano C, Manolaraki F, Brunet S, Ojeda-Robertos N, Fourquaux I, *et al*. Direct and indirect effects of bioactive tannin-rich tropical and temperate legumes against nematode infections. Veterinary Parasitology 2012;186:18-27.
22. Brunet S, Jackson F, Hoste H. Effects of sainfoin (*Onobrychis viciifolia*) extract and monomers of condensed tannins on the association of abomasal nematode larvae with fundic explants. International Journal for Parasitology 2008;38:783-790.

23. Akhtar MS, Ahmad I. Evaluation of antinematodal efficacy of tetrahydroharmine in goats. Veterinarski Arhiv 1999;61:307-311.
24. Shalaby HA, Namaky AH, Khalil FA, Kandil OM. Efficacy of methnolic extract of *Balanites aegypitiaca* fruit on *Toxocara vitulorum*. Veterinary parasitology 2012;183:386-392.
25. Nwude N, Ibrahim MA. Plants used in traditional veterinary medical practice in Nigeria. Journal of Veterinary Pharmacology and Therapeutics 1980;3:261-273.
26. Dubey MP, Gupta I. Anthelmintic activity of *Alangium lamarckii*. Indian Journal of Physiology and Pharmacology 1969;12:35-36.
27. Minja MMJ. Collection of Tanzanian medicinal plants for biological activity studies. In Proc. of the 7th Tanzania Veterinary Association Science Conference, Arusha 1989;7:67-78.
28. ITDG and IIRR. Ethnoveterinary medicine in Kenya: a field manual of traditional animal health care practices. Nairobi, Intermediate Technology Development Group and International Institute of Rural Reconstruction 1996.
29. Ibrahim MA, Nwude N, Ogunsusi RA, Aliu YO. Screening West African plants for anthelmintic activity. ILCA Bulletin 1984;17:19-23.
30. Fernandez TJ. Local plants having anthelmintic activity. ASEAN Journal of Sciences and Technology Development 1991;8:115-119.
31. Bories C, Loiseau L, Cortes D, Myint SH, Hoquemiller R, Gayral P, *et al*. Antiparasitic activity of *Annona muricata* and *Annona cheromolia* seeds. Planta Medica 1991;54:434-436.
32. Roepke DA. Traditional and re-applied veterinary medicine in East Africa. In McCorkle CM, Mathias E, Schillhorn TW, van Veen, eds. Ethno veterinary res. and devel. London, Intermediate Technology Publication 1996.
33. Akhtar MS, Chattha MI, Chaudry AH. Comparative efficacy of santonin and piperazine against *Neoascaris vitulorum* in buffalo calves. Journal of Veterinary Pharmacology and Therapeutics 1982;5:71-76.
34. Farnsworth NR, Akerele O, Bingel AS, Soejarto DD, Guo Z. Medicinal plants in therapy. Bulletin World Health Organization 1985;63(6):965-981.
35. Sherif A, Hall RG, El-Amamy M. Drugs, insecticides and other agents from Artemisia. Medical Hypotheses 1987;23:187-193.
36. Metha RK, Parashar GC. Effect of *Butea frondosa*, *Vernonia anthelmintica*, and *Carica papaya* against Oxyurids in mice. Indian Veterinary Journal 1966;43:73-78.
37. Lal J, Chandra S, Raviprakash V, Sabir M. *In vitro* anthelmintic action of some indigenous medicinal plants on *Ascaridia galli* worms. Indian Journal of Physiology and Pharmacology 1976;20:64-68.
38. Akhtar MS, Javed I, Hayat CS, Shah BH. Efficacy and safety of *Caesalpina crista* Linn. Seeds, its extracts in water and methanol against natural *Neoascaris vitulorum* infection in buffalo calves. Pakistan Veterinary Journal 1985;5:192-196.
39. Adewunmi CO, Akubue PI. Preliminary studies on the anthelmintic properties of the aqueous extract of *Callindra portoricensis* (Jacq.) Benth. Bulletin of Animal Health and Production in Africa 1981;29:171-175.
40. Mursof EP, He S. A potential role of Papaya latex as an anthelmintic against patent *Ascaridia galli* in chicken. Heamara Zoa 1991;74:1-5.
41. Satrija F, Nansen P, Bjørn H, Murtini S, He S. Effect of papaya latex against *Ascaris suum* in naturally infected pigs. Journal of Helminthology 1994;68:343-6.
42. Satrija F, Nansen P, Murtini S, He S. Anthelmintic activity of papaya latex against patent *Heligmosomoides polygyrus* infections in mice. Journal of Ethnopharmacology 1995;48:161-164.
43. Rebrassier RE. Pyrethrum as an anthelmintic for *Ascaridia lineata*. Journal of American Veterinary Medicine Association 1934;84:645-648.
44. Sen HG, Joshi BS, Parthasarathy PC, Kamat VN. Anthelmintic efficacy of Diospyrol and its derivatives. Arzneimittelforschung 1974;24:2000-2003.
45. Chakraborty B, Ray NM, Sidkar S. Study of anthelmintic property of *Tribulus terrestris* Linn. Indian Journal of Animal Health 1979;1:23-25.
46. Padmaja VV, Thankamany, Hisham A. Antibacterial, antifungal and anthelmintic activities of root barks of *Uvaria hookeri* and *Uvaria narum*. Journal Ethnopharmacology 1993;40:181-186.
47. Mehta RK, Parashar GC. Effect of *Butea frondosa*, *Vernonia anthelmintica* and *Carica papaya* against oxyurids in mice. Indian Veterinary Journal 1966;43(8):744-748.
48. Al-Mathal EM, Foud MAH. Myrrh (*Commiphora molmol*) in treatment of human and sheep dicrocoeliasis dendriticum in Saudi Arabia. Journal of the Egyptian Society of Parasitology 2004;34(2):713-720.
49. Sheir Z, Nasr AA, Massoud A, Salama O, Badra GA. Shennawy El, *et al*. A safe, effective, herbal anti-schistosomal therapy derived from myrrh. American Journal of Tropical Medicine and Hygiene 2001;65:700-704.
50. Barakat R, Elmorshedy H, Fenwick A. Fenwick Efficacy of myrrh in the treatment of human *Schistosomiasis mansoni*. The American Journal of Tropical and Medicine Hygiene 2005;73(2):365-67.
51. Haridy FM, Dawoud HA, Morsy TA. Efficacy of *Commiphora molmol* (Mirazid) against sheep naturally infected with monieziasis expansa in Al-Santa Center, Gharbia Governorate, Egypt. Journal of the Egyptian Society of Parasitology 2004;34(3):775-782.
52. Handa SS, Kapoor VK. Pharmacognosy, Vallabh Prakashan, New Delhi 1998, 240-245.
53. Asha MK, Prashant D, Murali B, Padmaja R, Amit A. Antihelminthic activity of essential oil of *Ocimum santum* and *Eugenol*. Fitoterapia 2001;72:699-670.
54. Szewezuk VD, Mongelli ER, Pomilio AB. Antiparasitic activity of *Melia azedarach* growing in Argentina. Molecular Medicine and Chemistry 2003;1:54-57.
55. Cumming JN, Ploypradith P, Posner GH. Antimalarial activity of artemisinin (qinghaosu) and related trioxanes: mechanism(s) of action. Advances in Pharmacolology 1997;37:253-297.
56. Da Silva IC, de MagalhÃ£es PM, de Oliver Sousa IM, Foglio MA, Leonardecz E, Esteves SN, *et al*. Anthelmintic activity of *Artemisia annua* in sheep-model. Journal of Medicinal Plant Research 2017;11(7):137-143.
57. Mali RG, Mehta AA. A Review on Anthelmintic Plants. Natural Product Radiance 2008;7(5):466-475.

58. Kumar D, Mishra SK, Tandan SK, Tripathi HC. Mechanism of anthelmintic action of benzyl isothiocyanate. Fitoterapia 1991;62(5):403-410.
59. Dhar RN, Garg LC, Phathak RD. Anthelmintic activity of *Carica papaya* seeds. Indian journal of pharmacology 1965;27(12):335-336.
60. Agarwal R, Kharya MD, Shrivastava R. Antimicrobial and Antihelmintic activities of essential oil of *Nigella sativa* Linn. Indian Journal of Experimental Biology 1979;17:1264-1265.
61. Akhtar MS, Riffat S. Field trial of *Saussurea lappa* roots against nematodes and *Nigella sativa* seeds against cestodes in children. Journal of Pakistan Medical Association 1991;41(8):185-187.
62. Forouzanfar F, Bazzaz BSF, Hosseinzadeh H. Black cumin (*Nigella sativa*) and its constituent (thymoquinone): a review on antimicrobial effects. Iranian Journal of Basic Medical Sciences 2014;17(12):929.
63. Salem ML. Immunomodulatory and therapeutic properties of the *Nigella sativa* L. seed. International Immunopharmacology 2005;5(13-14):1749-1770.
64. Pal P, Tandon V. Anthelmintic efficacy of *Flemingia vestita* (Fabaceae): genistein-induced alterations in the activity of tegumental enzymes in the cestode, *Raillietina echinobothrida*. Parasitology International 1998;47:233-243.
65. Tandon V, Das B, Saha N. Anthelmintic efficacy of *Flemingia vestita* (Fabaceae): effect of genistein on glycogen metabolism in the cestode, *Raillietina echinobothrida*. Parasitology International 2003;52:179-183.
66. Ali SA. Natural products as therapeutic agents for schistosomiasis. Research Journal of Medicinal Plants 2011;5:1-20.
67. Heckendorn F, Lèbre A, Destailleur V, Bouy M, Spiegler V, Lehmann S, *et al*. Anthelmintic effect and intake dynamics of oak (*Quercus* spp.) and walnut (*Juglans regia*) foliage in goats. Planta Medica International Open - GA 2017 - Book of Abstracts. 2017;4(S-01):S1-S202.
68. Mali RG, Mahajan SG, Mehta AA. Invitro anthelmintic activity of stem bark of *Mimusops elengi* Linn. Pharmacognosy Magazine 2007;3(10):73-76.
69. Prakash KD, Singhal KC and Gupta RR. Antihelmintic activity of *Punica granatum* and *Artemisia silversiana*. Indian Journal of Pharmacology 1980;12:62-65.
70. Pradhan KD, Thakur DK, Sudhan NA. Therapeutic efficacy of *P. granatum* and *C. maxima* against clinical cases of nematodiasis in calves. Indian Journal of Indigenous Medicine 1992;9(1):53-54.
71. Ferreria LE, Benincasa BI, Fachin AL, Franca SC, Contini SHT, de Souza Chagas AC, *et al*. *Thymus vulgaris* L. essential oil and its main component thymol: Anthelmintic effect against *Haemonchus contortus* from sheep. Veterinary Parasitology 2016. DOI: 10.1016/j.vetpar.2016.08.011
72. Tariq KA, Tantry MA. Preliminary studies on plants with anthelmintic properties in Kashmir-the north-west temperate Himalayan region of India. Chinese Medicine 2012;3:106-112.
73. Tariq KA, Chishti MZ, Ahmad F, Shawl AS. Anthelmintic efficacy of *Achillea millifolium* against gastrointestinal nematodes of sheep: *in vitro* and *in vivo* studies. Journal of Helminthology 2008;82(3):227-233.
74. Tariq KA, Chisti MZ, Ahmad F, Shawl AS. Anthelmintic activity of extracts of *Artemisia absinthium* against ovine nematodes. Veterinary Parasitology 2009;160(1-2):83-88.
75. Khobragade VR, Jangede CR, Maske KD. *In vitro* anthelmintic trial of extract of *Allium sativum* Linn. against *Bunostomum trigonocephalum* in goats. Journal of Veterinary Parasitology 1994;2:97-98.
76. Meschler JP, Howlett AC. Thujone exhibits low affinity for cannabinoid receptors but fails to evoke cannabimimetic responses. Pharmacology Biochemistry and Behavior 1999;62:473-480.
77. Lourenco PML, Figueiredo AC, Barroso JG, Pedro LG, Oliveira MM, Deans SG, *et al*. Essential oils from hairy root cultures and from plant roots of *Achillea millefolium*. Phytochemistry 1999;51:637-642.
78. Iqbal Z, Lateef M, Akhtar MS, Ghayur MN, Gilani AH. *In vivo* anthelmintic activity of ginger against gastrointestinal nematodes of sheep. Journal of Ethnopharmacology 2006;106:285-287.
79. Wagay N. Ethnobotany from North Kashmir- a review. Life Sciences Leaflets 2016;80:38-60.