Role of Medicinal Plants against *Haemonchus contortus*

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Abstract

Haemonchus contortus, a highly pathogenic gastrointestinal nematode, is a threat to ruminants, mainly sheep and goats, and thus leads to great economic losses in the world. Traditional control approaches based on synthetic anthelmintics are being challenged more and more by the emergence of drug-resistant parasite strains, expensive therapy, and fears for the toxicity of the surrounding environment. As a response, there has been an enhancement of prospects in the medicinal plants, as they carry a rich arsenal of bioactive phytochemicals such as tannins, alkaloids, flavonoids, and saponins. These compounds possess strong anthelmintic activities that interfere with the parasite's metabolic and reproductive processes and consequently do not have much host toxicity. This review examines the therapeutic potential of medicinal plants like *Azadirachta indica, Allium sativum, Zingiber officinale,* and *Curcuma longa,* demonstrating their pharmacological aspects, safety profiles, and feasibility regarding the economics of livestock management health. Ecological and cultural significance of plant-based treatments, antioxidant and antimicrobial properties of plant-based treatments, and prospects of changing parasitic disease control in sustainable veterinary practice are focused on.

Keywords: *Haemonchus contortus*, Anthelmintics, Resistance, Alternatives, Medicinal Plants, Control

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Introduction

The dominant and destructive nematode of blood-feeding gastrointestinal type, Haemonchus contortus, significantly complicates livestock health. This parasite inflicts severe damage on sheep and goats, leading to devastating economic losses in the industry. By causing anemia, diarrhea, and significant weight loss, H. contortus weakens animals, reduces productivity, and threatens the sustainability of livestock farming (Adduci et al., 2022). Haemonchosis significantly impacts livestock productivity, causing a 29% drop in milk yield, resulting in an annual loss of PKR 134,062.39 million. Additionally, a 27% reduction in body weight leads to financial damages exceeding PKR 40 million. Young animals are the most affected, with total losses reaching hundreds of crores. Mortality due to haemonchosis alone accounts for PKR 142,902 million annually, while treatment costs add up to PKR 25 million per year (Qamar et al., 2011). In Kenya, the yearly cost of treating H. contortus infections is estimated at $26 million. South Africa faces an even higher financial burden at $46 million, while India incurs a staggering $103 million annually.

Developing plant-based anthelmintics that are affordable, easily accessible, and low-risk is crucial (Pratiwi & Novitarini, 2025). The perfect anthelmintic should be a powerhouse, broad-spectrum, highly effective in a single dose, safe for the host, and affordable. Yet, most synthetic drugs miss the mark, bringing side effects like nausea, drowsiness, and digestive distress. With growing resistance and soaring costs, the search for potent alternatives has led to nature's pharmacy plants. Rich in bioactive compounds designed for survival, these botanical wonders offer a natural, accessible, and powerful defense against helminth infections, especially in tropical and developing regions (Ahmed et al., 2023). This chapter explores the chemical composition of medicinal plants and their mechanism of action against *H. contortus*.

Herbal medicine is widely embraced in developed nations, with usage rates reaching 75% in France, 70% in Canada, and nearly half the population in Australia and the USA turning to plant-based remedies. In Malaysia, spending on herbal healthcare exceeds US$ 500 million annually, outpacing the US$ 300 million spent on conventional medicine. Investments in modern treatments in the USA are estimated to be almost US$ 2700 million per year, but natural options prevail on the global market. Notably, the annual herbal medicine spending in Canada has skyrocketed to reach US$ 2400 million, in the UK – US$ 2300 million, in Australia – US$ 80 million, which is a global trend toward holistic wellness. The global market for herbal medicinal products is still growing fast so far as there is an increasing bias and demand from consumers. Medicinal plants have been used for centuries in different parts of the world, and they continue to be an important part of primary healthcare for many populations especially those in indigenous contexts because they are seen to be safe and effective in their healer properties (Rahman et al., 2004; El-Ghazali et al., 2010; Daur, 2012).

Medicinal plants found in Bahra and Hada, namely *Achillea fragrantissima, Amaranthus viridis, Asteriscus graveolens, Chenopodium*

album, and *Conyza bonariensis,* were assessed for good sources of mineral contents such as magnesium, calcium, chromium, and iron. Similarly, the tested plants had high levels of phenolic compounds, potent antioxidant activity, and excellent free radical scavenging ability, hence revealing their therapeutically powerful potential. Furthermore, the medicinal plants continue to have such an important role in the daily life of people of many developing countries in Asia and Africa, with Ethiopia being a good example. These natural remedies are strongly steeped in tradition and are vital to healthcare regimens in such areas. They are primary and alternative solutions to healthcare, particularly where the availability of modern medical services is poor.

Beyond their therapeutic benefits, these plants contribute to the well-being and security of local communities, deeply embedded in cultural traditions and economic practices. From birth to old age, sickness to healing, and even life to death, medicinal plants hold significant value. For centuries, they have been trusted for diagnosing and treating various diseases and infections, offering natural and effective remedies (Agidew, 2022). Nature's secret arsenal holds powerful nematocidal warriors. Medicinal plants like *Lippia viridiflora*, *Corymbia citriodora*, *Calotropis procera*, and *Artemisia herba-alba* emerge as potent defenders against *H. contortus*. Meanwhile, bioactive gems anethole and carvone emerge as game-changers, holding the key to revolutionary, plant-powered anti-parasitic drugs (Ali et al., 2021). This chapter discusses about chemical composition and biological activities of medicinal plants. It also explains the role of medicinal plants against *H. contortus*. Limitations of medicinal plants are also included in this chapter.

Chemical Composition of Medicinal Plants

Medicinal plants serve as a foundational resource for drug discovery, providing natural, cost-effective healthcare alternatives. They generate phytochemicals that are vital for human health, yet cannot be produced endogenously by the human body (Shakya, 2016). Many plants possess remarkable healing abilities, largely due to the presence of bioactive metabolites, which are generally grouped into primary and secondary categories.

Primary metabolites are also composed of organic substances that are vital to the body, such as starch, polysaccharides, glucose, proteins, lipids, among others, which are important within the body's growth and development (Iqbal et al., 2025). Secondary metabolites are attributed to the medicinal value of plants and consist of various types of compounds (alkaloids, flavonoids, saponins, terpenoids, steroids, glycosides, tannins, and volatile oils). These natural compounds are key to health as they help to promote health and treat disease. Alkaloids alleviate pain, make muscles relax, assist in the treatment of malaria, and the removal of excess fluids (Sajid et al., 2025). Terpenoids are joyfully known for their super antiviral, antibacterial, anticancer, and anti-inflammatory activity (Chopra et al., 2022; Mohammadi-Cheraghabadi & Hazrati, 2023). Glycosides help fight against fungal and bacterial diseases (Li et al., 2019; Sati et al., 2019). Phenolic compounds and flavonoids have considerable antioxidant properties, and they also have antibacterial and anti-allergic properties (Ahmed et al., 2024; Zhou et al., 2024). The saponins will add to the defense of the plant and, at the same time, help to eliminate inflammation in humans and kill viruses (Hussain et al., 2019; Wijesekara et al., 2024). The two bioactive substances, therefore, explain the immense potential in medicinal plants as therapeutic agents and the continued relevance of these plants in traditional healing and contemporary pharmaceutical development (Chopra & Doiphode, 2002; Maurya et al., 2008).

Medicinal plants are a crucial source of bioactive compounds, driving pharmaceutical innovation and drug creation. Worldwide, over 35,000 plant species are used for healing, especially in developing regions where traditional plant-based medicine is central to healthcare. Various species, including A. vera, Z. officinale, C. longa, O. sanctum, and A. indica, exhibit therapeutic potential in managing respiratory disorders (KhokharVoytas et al., 2023). These plants contain diverse bioactive constituents, such as tannins, alkaloids, flavonoids, terpenoids, steroids, and sugars, contributing to their pharmacological efficacy. Interestingly, E. purpurea and Z. officinale have helped cure respiratory ailments such as COPD, bronchitis, asthma, and cold, among others. Additionally, many common applications of traditional medicine that use the leaves of A. torta, O. sanctum, M. haplocalyx, L. virosa, C. pluricaulis, and A. indica have traditionally been used to treat bronchitis, asthma, and coughs. These plants remain of crucial significance in respiratory health due to their natural healing abilities. These medicinal plants offer a great prospect for identifying new medications targeting respiratory diseases (Firdaus et al., 2025).

Biological Activities of Medicinal Plants

Pharmacognosy, the study of medicinal compounds from natural sources, was introduced by Schmidt in 1811. The term is derived from the Greek words "pharmakon" (drug) and "gnosis" (knowledge), reflecting its focus on the healing power of nature. It focuses on identifying bioactive compounds, particularly phytochemicals, which are plant-derived compounds with therapeutic properties as shown in Figure 1. A crude drug refers to an unprocessed natural substance used in medicine. Phytochemicals, including alkaloids, flavonoids, steroids, and tannins, play a key role in drug discovery (Sharma & Kumar, 2013). Over 4,000 phytochemicals have been identified, with 150 extensively studied for pharmacological effects. Many exhibit antimicrobial, antimalarial, antidiabetic, and anticancer activities. Their chemical properties and medicinal potential make phytoconstituents essential for modern herbal drug development (Bhat, 2021).

Role of Medicinal Plant against Animal Pathogen

The increasing resistance to synthetic anthelmintics has intensified the need for novel preventive and therapeutic strategies. Consequently, there is a growing focus on plant-based medicines and alternative approaches for effective parasite control (Fissiha & Kinde, 2021). Plant-derived tannins and flavonoids exhibit significant antiparasitic properties. Moreover, *Allium sativum*, commonly known as garlic, is celebrated for its strong antimicrobial power, largely due to the presence of allicin and sulfur-rich compounds (Bhatwalkar et al., 2021). Widely used both as fresh and as a supplement, it helps fight numerous infections and supports immune health. Though generally safe, high doses may cause digestive discomfort and could interact with blood-thinning medications. Therefore, careful management and consideration of dosage are essential to mitigate adverse effects (Magryś et al., 2021).

Medicinal plants have historically been utilized for the treatment of parasitic infections and continue to serve this purpose in various

regions worldwide. In ethnoveterinary medicine, which is rooted in traditional healing practices, a diverse range of plants and plant extracts are reportedly effective in managing nearly all parasitic diseases affecting livestock. The seeds of *A. sativum* (garlic), *A. cepa* (onion), and Mint species (mint) have been traditionally utilized for the treatment of gastrointestinal parasitism in animals. Also, extracts from the *N. tabacum* (tobacco) plant have been used for the control of external parasites that attack livestock (Ishaq et al., 2023).

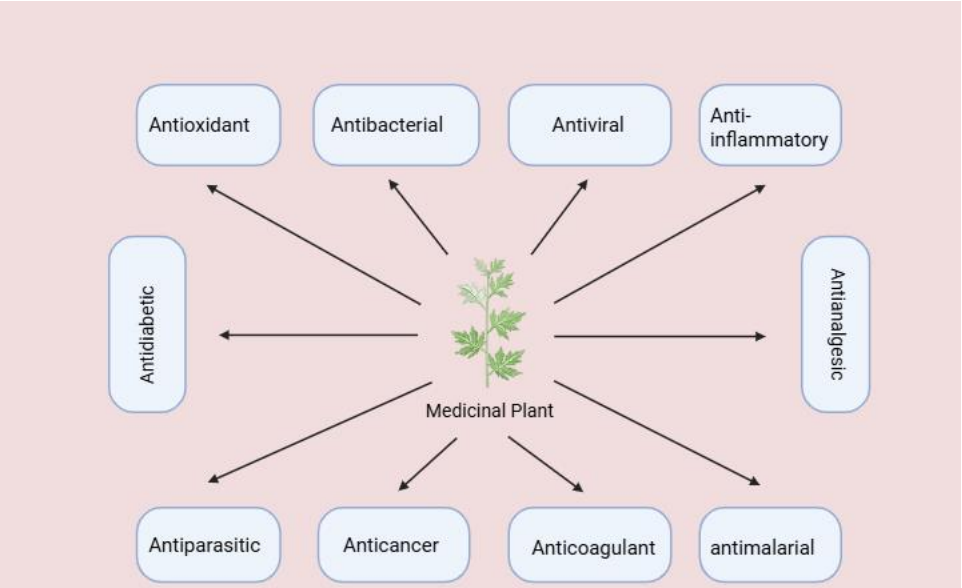

Fig. 1: A diagrammatic representation of the pharmacological activities of the Medicinal Plants.

Significance of Medicinal Plants on *H. contortus*

Anthelmintic resistance that has surfaced on *H. contortus*, which is one of the highly pathogenic gastrointestinal nematodes of ruminants, has resulted in several studies seeking alternative forms of control. Medicinal plants are enjoying recognition due to bioactive phytochemicals such as tannins, flavonoids, alkaloids, and saponins in them that have a known anthelmintic effect. These compounds intercept the vital biology of the parasite, including hatching of eggs, development of larvae, and locomotion of adults (Hrckova et al., 2013). Medicinal plants have come out as an alternative in the war against *H. contortus* with their natural and powerful anthelmintic properties. Some of the plants, including *A. indica* (neem), *A. sativum* (garlic), *C. pepo* (pumpkin), and *T. diversifolia,* have been identified to contain active compounds like alkaloids, flavonoids, and saponins, which interfere with parasites' metabolism and reproduction cycle, as shown in Table 1. Bioactive compounds can hinder or kill the worms, whether by directly destroying their cellular structures, as shown in Figure 2, or stopping their nutrient absorption. Not only are these plants effective in minimizing parasite loads, but they are also relatively safe for livestock when used properly. Their low toxicity profile is making them an interesting choice for organic and sustainable farming systems. Also, medicinal plants can act as complementary treatments with the conventional anthelmintics in improving the effectiveness, as well as help to avoid resistance development (Patra et al., 2019).

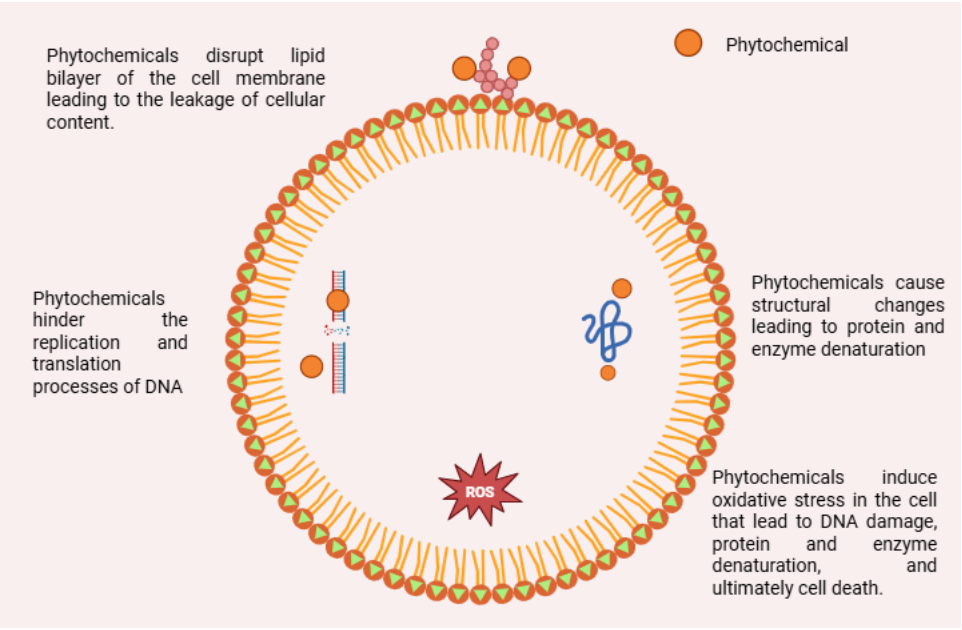

Fig. 2: A cellular level mechanism of action of phytochemicals in opposition to *H. contortus* (as depicted diagrammatically).

Table 1: Depicts the name of plants, phytochemicals, and pharmacological activities of various extracts of the plants and how they act against *H. contortus*

Plant species	Common Name	Phytochemicals	Pharmacological Activity	Mode of action	References
C. longa	Haldi	2% volatile oil, α- and β-turmerone, monoterpenes, Flavonoid	Cardiovascular effect, anticancer, liver, neuroprotective, and digestive benefits,	Disrupt its neuromuscular activity and cause tegumental damage.	(Sharma, 2013)
Z. officinalis	Ginger	Mono and sesquiterpenoids, Zingerone, and gingerols	Anti-cancerous, Antioxidant, Hepatoprotective, hypocholesterolemic, anti-atherosclerotic	Cause paralysis and structural damage through its active compounds	(Umadevi et al., 2012)
A. sativum	Garlic	Allicin, Ajoene, Querciten, Alliin, Flavonoids	Exhibiting anticancer, antioxidant, antidiabetic, and nephroprotective, anti-atherosclerotic, antibacterial, antifungal, and antihypertensive activities.	Inhibit key enzymes involved in the parasite's energy metabolism, leading to its death.	(Beshbishy et al., 2020)
A. A. indica	Neem	Quercetin, limonoids, nimbin, tannins,	Immunomodulatory, anti-inflammatory, antihyperglycaemic, antiulcer, antimalarial, antifungal, antibacterial, antiviral, antioxidant, antimutagenic, and anticarcinogenic activities.	Causes paralysis and death of the worms, likely due to its bioactive compounds such as tannins and alkaloids.	(Uzzaman, 2020)
M. Oleifera	Sohanjna	Flavonoids, Phenolic acids, Terpenoids, Vitamins, Minerals	Antioxidant, Anticancer, Antidiabetic, Hepatoprotective, Antimicrobial, Anti-atherosclerotic, Antihypertensive	*M. oleifera* acts against *H. contortus* by disrupting neuromuscular activity and causing tegumental damage through its bioactive compounds	(Mishra et al., 2011)

Advantages, Limitations, and the Necessity for Scientific Validation

Herbal medicine is accepted across the globe due to proven efficiency and cost-effectiveness in healthcare. Nowadays, an interest in using environment-friendly and biocompatible plant-originated remedies is increasing. These natural solutions are increasingly valued for their potential in treating a wide range of human diseases with minimal side effects (Sathiyaraj et al., 2015). The rising demand for pharmaceuticals has increased the use of medicinal plants, posing a threat to their biodiversity. Advanced research is needed to develop safe and effective natural drugs through improved screening methods, as mentioned in Table 1. Additionally, scientific validation of medicinal plants is essential for their therapeutic use (Durairaj & Kamaraj, 2013; Shah et al., 2015).

Parasitic diseases remain a significant global public health challenge, particularly in tropical and developing regions where they affect millions of individuals. The limited accessibility and high cost of pharmaceutical treatments have led a substantial portion of the population to rely on traditional medicinal plants for healthcare. It is estimated that approximately 20,000 species of higher plants are utilized for medicinal purposes worldwide.

Conclusion

Medicinal plants such as *A. indica*, *Allium sativum*, *Z. officinale*, and *C. longa* offer promising alternatives to conventional anthelmintics for controlling *H. contortus* in livestock. These plants, rich in bioactive compounds, provide effective, eco-friendly, and culturally relevant solutions with minimal toxicity to host animals. Their antioxidant, antimicrobial, and anthelmintic properties make them valuable in sustainable veterinary practices. Further research is needed to optimize their use and ensure their economic feasibility in large-scale livestock management. Ultimately, plant-based treatments could significantly reduce the dependence on synthetic drugs, enhancing both animal health and agricultural sustainability.

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