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Herbal anthelmintic plants: A Comprehensive review of Traditional knowledge and Scientific evidence

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ABSTRACT
Anthelmintic drugs are used to treat helminthiasis, a condition brought on by parasitic worms known as helminths. These worms can infect both people and animals, resulting in a variety of illnesses and health problems. In order to assess the effectiveness of various medicinal plants as anthelmintics, researchers investigated alternatives to conventional medicine and performed studies. In these investigations, several screening techniques and strategies have been used to identify the potential anthelmintic activity of plant species. These plants' extracts include bioactive substances that may disrupt the systems and metabolism of the parasites, resulting in their anthelmintic activity. According to the research so far, traditional medicinal herbs have the potential to produce entirely new, powerful anthelmintic chemicals. In order to replace currently available synthetic medications, which frequently have drawbacks and undesirable side effects, researchers are actively exploring such herbal remedies.
Keywords: *Anthelmintic, Herbal, Medicinal plants, Earthworms, Worm expulsion.*

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INTRODUCTION

Natural remedies are available to treat all human ills and diseases that are related to them. Compared to other animal species, humans tend to be more susceptible to disease.[1]The socioeconomic conditions of Asian and African nations make it difficult for many peasants and tribes living in far-flung regions and dense forests to pay or access modern medicine. In some areas of a country like India, tribal people lack access to modern conveniences like electricity, roads, and telecommunications, thus they must rely solely on their traditional medical expertise to meet their daily needs.[2] Nowadays more people prefer to take charge of their health through the use of herbal remedies for a number of reasons, including not just to treat illnesses but also to avoid them. This is especially true for a variety of diseases that can be treated at home.[3] A significant majority of the world's population is prone to helminthic infections, which are among the most prevalent illnesses in humans. Plant based remedies, especially in tropical developing nations like India, hold enormous potential as a source of readily available, efficient anthelmintic drugs for people worldwide.[4]

Helminthiasis Disease

Any macroparasitic disease affecting both humans and other animals and characterized by the presence of parasitic worms called helminths in a specific body region is referred to as helminthiasis.[5] Today, helminth parasites make up the most prevalent infectious diseases, affecting around one-third of the global population. and causing a wide range of painful diseases and syndromes. Helminths are also common in cattle and result in significant losses to agriculture. Helminths create long-lasting, chronic infections in both human and animal hosts, along with considerable levels of host immune response downregulation. The goal of eradicating helminth illnesses is still far off due to an absence of effective vaccines, constrained pharmaceutical efficacy, evolving drug resistance, and rapid reintroduction in situations where the spread cannot be stopped.[6]

Multicellular worms called helminths are classified into three taxonomic groups: cestode tapeworms, nematode roundworms, and trematode flukes. [7] They frequently reside in the gastrointestinal tracts of their hosts, but they can also enter other organs and result in physiological harm there.[5]These parasites have remarkably varied life histories, including direct faecal-oral transmission , growth via free-living stages, and reliance on invertebrate vectors . Similar to parasites, helminths can enter the body by a number of different routes, including contact with the skin (schistosomes and hookworms), bites from mosquitoes (filarial worms), and, most commonly, the digestive tract.[7]

It may be wise to check for infection in other family members when one person is found to be infected. Patients should be reminded to practice good personal cleanliness and to take precautions while preparing food, but they should also be reassured that most helminths do not typically spread easily within the home.[8]Clinical signs of helminthiasis include the following four fundamental symptoms:

One may simply proactively avoid the disease if we are aware of the parasitic worms' locations and the mode of transmission. Spread the word and educate people about the importance of food culture. Clean your food well before eating it and drinking it. This is especially important in residential regions where people have a practice of eating raw, rare, and utilizing blood soup.[9] There is usually a rise in awareness but not always an alteration in behaviour when individuals are educated about the illness and encouraged to take preventive measures.[10]

Educational materials (posters, brochures, broadcasting, and video footage messages) are among the traditional ways to spread health-related messages, but techniques used in the private sector are currently being encouraged for their potential value in creating and disseminating health-related messages.[11,12]

Frequent medication therapy is the primary method of infection control in regions with high rates of infection transmission, little resources for disease prevention, and inadequate funding for sanitary facilities. Alternative methods of administering drug treatment in society at large include: universal treatment, which provides care to everyone in the community regardless of age, sex, infection status, or other social characteristics; targeted treatment, which provides care to population groups based on age, sex, or other social characteristics regardless of infection status; and particular treatment, which administers care at each person's level.[13]

Classes of synthetic anthelmintic drugs

Anthelmintics are a diverse group of medications that are grouped into classes based on similarities in their chemical structure and modes of action.

- Benzimidazole

Thiabendazole is a broad-spectrum anthelmintic that was first identified in 1961. The literature on benzimidazole compounds is broad and demonstrates a variety of biological effects. The capacity of benzimidazoles to selectively bind with tubulin factor and compromise the cytoskeleton accounts for their effectiveness as anthelmintics.[14] Through this, the chemical basis of benzimidazole molecule resistance in parasitic nematodes has been discovered. *Haemonchus contortus*, a worm, exhibited resistance to the benzimidazole molecule, which is linked to the drug's presence of particular alleles of tubulin .[15]

- Ivermectin

It is an effective medication, and its discovery sparked the creation of ivermectin analogues such as moxidectin, milbemycin oxime, doramectin, selamectin, abamectin, and eprinomectin. Pharyngeal and body wall muscles are paralyzed by ivermectin.[16]

- Emodepside

Cyclodepsipeptide molecule and semi-synthetic derivative emodepside. a substance produced by fermenting *Mycelia sterilia*, a fungus. Recently, its anthelmintic properties and discoveries were found.[17]

- Piperazine

It is the most well-liked and frequently applied medication for the treatment of parasitic illness. Piperazine was first used as an anthelmintic in the 1950s, and it is currently an active ingredient in several over-the-counter medications and treatments for pediatric thread worm infections.[14]

- Levamisole, Pyrantel and Morantel

These anti-helminthics are nicotinic receptor agonists that result in spastic muscular paralysis and sustained activation of the excitatory nicotinic acetylcholine (nACh) receptors on muscle.[18]

- Paraherquamide

Penicillium paraherquei and *Penicillium roqueforti*, which produce the drugs paraherquamide and marcfortine A, respectively, are both members of the oxindole alkaloid family.[19] Parasitic nematodes undergo flaccid paralysis when exposed to paraherquamide or its derivative, deoxyparaherquamide.[18]

- Nitazoxanide

The pyruvate ferredoxin oxidoreductase inhibitor nitazoxanide is effective against a variety of intestinal protozoa and helminths. Because putative targets for this substance include anaerobic electron transport enzymes, its mode of action in nematodes has not been determined.[20] Nitazoxanide stops population growth after seven days in culture by 33%. Mebendazole and albendazole, in contrast, significantly slowed the growth (by over 90%). As a result, as compared to other anthelmintic medications, this compound's effectiveness is rather modest. [1]

Since there are currently no vaccinations in the market, controlling helminths must instead rely on some effective medications, known as anthelmintics. However, because these drugs are frequently misused, major drug resistance issues arise throughout the world, necessitating the urgent need to isolate and find novel anthelmintic drugs.[21]

An ideal anthelmintic agent would be one that has a broad scope of action, provides a significant number of cures with a single therapeutic dose, is not harmful to the host, and is reasonably priced. None of the synthetic drugs on the market satisfies this criterion. There is evidence that even the most widely used medications, can cause digestive issues, giddiness, and nausea.[22] Tolerance of the infections to the current therapies and their expensive price justifies the need to search for fresher anthelmintic compounds. Due to the fact that many effective medications have their roots in traditional medical procedures, various researchers have conducted studies to assess the purported anthelmintic efficiency of folkloric medicinal plants.[4]

In order to find novel potential anthelmintic molecules and to determine their potential mechanism(s) of action, researchers have evaluated the effectiveness of plant species through a variety of screening procedures and approaches. These efforts have been reviewed further.

Methods for Studying Anthelmintic Activity

1. Most *in vitro* studies on the anthelmintic properties of plants, their oils, or their extracts have been conducted based on their toxicities to earthworms. The majority of compounds that are poisonous to earthworms cause an initial irritability or agitation, which causes the worm to die. Anthelmintics possibly sometimes eject the parasite due to this effect if their concentration does not increase enough to kill the worm.
2. Hookworms, *H. contortus*, tapeworms, and/or A. lumbricoides have also been utilized by certain researchers to assess the *in vitro* anthelmintic activity of various plant materials..[23]
3. To assess the effectiveness of plant items against the eggs of *Haemonchus contortus* or other trichostrongylids, a modified egg hatch assay is frequently utilized.
4. A modified version on the larval development assay (LDA) or larval motility assays, which are frequently used to test a parasite's resistance to anthelmintics, have been employed by some other researchers doing *in vitro* studies.[24]
5. In one of the anthelmintic activity investigation, worms from houseflies that mimic parasitic pinworms found in humans were produced under laboratory settings, revealing a novel technology. Using housefly worms and earthworms, researchers examined the anthelmintic effects of several medications.[25]
6. The effectiveness of several plant materials as anthelmintics has additionally been tested in vivo. The criteria for this kind of activities included the evacuation of worms from their hosts or a decrease in the quantity of eggs per gram of faeces (EPG) that the hosts with the infection passed when compared to animals that had been given commercial anthelmintics. As an example, oral feeding of Indonesian papaya (Carica papaya) decreased parasite burden up to 100% within seven days after treatment for pigs who were infected with *Ascaris suum*. Similar to this, various other plant extracts discovered with anthelmintic qualities were examined for their effectiveness against gastrointestinal nematodes in experimentally infected sheep.[24]

Plants studied for anthelmintic activity

- *Adhatoda vasica* (Family- Acanthaceae)

Crude aqueous (CAE) as well as methanol extracts (CME) of A. vesica had an anthelmintic impact on live *Haemonchus contortus*, as shown by the mortality of the test subjects, according to *in vitro* tests. Sheep already infected with a variety of gastrointestinal nematodes were given A. vesica roots as crude powder (CP), CAE, and CME for *in vivo* experiments. Despite having anthelmintic efficacy against nematodes, it was discovered that A. vesica roots did not compare to Levamisole.[26]

- *Aerva lanata Linn Juss* (Family- Amaranthaceae)

According to the findings, both the methanolic and aqueous extract of Aerva lanata's aerial parts exhibit anthelmintic activity when compared to the common medication. Each crude extract demonstrated anthelmintic action in a dose-dependent manner at concentrations of 25, 50, and 100 mg/ml. *Aerva lanata*

aerial parts extraction in methanol at a dosage of 100 mg/ml caused paralysis in 7.5 minutes and death in 11.16 minutes, whereas aqueous extract against *Pheritima postuma* exhibited paralysis in 13.83 minutes and death in 18 minutes. Piperazine citrate, the standard of reference, demonstrated identical results at 14.16 and 31.83 minutes, respectively. Given the paralysis's shortest duration (P) and death (D) with 100 mg/ml concentration. The reference medication, piperazine citrate, demonstrated the same at 14.16 and 31.83 minutes, respectively. The traditional utilization of Aerva lanata's aerial parts as an anthelmintic has been verified, since the extracts have demonstrated action against *Pheritima postuma*.[27]

- *Annona squamosa* (Family- Annonaceae)

A. squamosa has therapeutic qualities. Internal roots are used to treat spinal disorders. Bark has a reputation for being a potent astringent. Fruits are regarded as good tonics in Ayurveda; they enrich the blood, are employed as expectorants, promote muscular strength, are cooling, lessen burning sensations and the tendency toward biliousness, are sedative to the heart, and alleviate vomiting. According to the study's findings, *Annona squamosa* Linn extracts of leaves had significantly higher anthelminthic activity than the standard the standard.[28]

- *Azadirachta indica* (Family- Meliaceae)

In this work, neem (Azadirachta indica) extracts from the leaves were tested in the laboratory with Fasciola spp. with albendazole, a commonly used dewormer, and nutritional broth, which served as a negative control. A comparison with the average recorded mean, the investigation identified the extract quantity which generated the highest effectiveness.[29]

- *Butea monosperma (Lam.)* (Family-Fabaceae)

The seeds have been shown to have anthelmintic activity and to be effective against ascarids. One investigation discovered that the isolated seed ingredient palasonin, a lactone (C16 H22O6), had considerable anthelmintic properties. [4] Palasonin appears to have an impact on the parasite's system for generating energy because it hindered glucose uptake and reduced the amount of glycogen in the presence of glucose. Additionally, lactic acid levels considerably increased, indicating ATP generation was being inhibited. The findings suggested that palasonin may exert its effects via impairing energy metabolism or by changing the parasite's motor activity.[30]

- *Buchholzia coriaceae* (Family- Capparidacea)

The anthelmintic abilities of *Buchholzia coriaceae* were genuine. With all of the worms utilized in the study, the extracts demonstrated concentration-related anthelmintic activity, with 100 mg/ml providing the shortest time for paralysis (P) and death (D). The findings revealed that for all of the worm kinds studied, the plant leaves had greater activity than the plant stems.[31]

- *Calotropis procera* (Family-Apocynaceae)

Through in vitro and in vivo investigations, the anthelmintic activity of Calotropis (C.) procera florals in contrast to levamisole was assessed.*Calotropis procera* floral crude aqueous and crude methanolic extracts both showed time-dependent anthelmintic efficacy *in vitro* against *Haemonchus contortus*.[32]

- *Cassia tora L.* (Family- Fabaceae)

According to research, the most effective *C. tora* extract is the ethyl acetate fraction since it kills worms faster and paralyzes them more quickly than the methanolic extract. Both extracts demonstrated anthelmintic properties that were concentration dependent. The extracts showed efficacy against the worms utilized in the study, supporting the traditional assertion that *C. tora* leaf is an anthelmintic.[33]

- *Coriandrum sativum* (Family- Umbellifers)

The aqueous and hydro-alcoholic extracts of Coriandrum sativum (Apiaceae) seeds were tested for their in vitro anthelmintic properties. Additionally, the *in vivo* anthelmintic activity of *Coriandrum sativum's* aqueous extract in sheep sick with *Haemonchus contortus* was examined. At a concentration of less than 0.5 mg/ml, *Coriandrum sativum's* two extract varieties fully prevented eggs from hatching. The ED50 of *Coriandrum sativum's* aqueous extract was 0.12 mg/ml, whereas that of its hydro-alcoholic extract was 0.18 mg/ml. Among aqueous and hydro-alcoholic extracts, there were no statistically noteworthy change ($p > 0.05$). *In vitro* tests against adult parasites indicated that the hydro-alcoholic extract was more efficient than the aqueous one.[34]

- *Cucurbita maxima Duch.* (Family-Cucurbitaceae)

The plant's seeds have a reputation in the Ayurvedic medical system as an anthelmintic, particularly against tape worms. Evaluated *in vivo* and *in vitro* using extracts of the seeds. Aqueous, alcoholic, and ether extracts in the *in vitro* trials were in decreasing order of extract potency. According to the kymographic tests, the seed extracts work by causing a reduction in motility, which results in momentary paralysis.[35]

- *Capparis decidua Edgew.* (Family-Capparidaceae)

It is a tiny, glabrous shrub that can be found in most of India. In the ancient medical system, root bark has been shown to be effective for treating helminthes infections, rheumatoid arthritis, cough, and asthma. The *Pheretima posthuma* (Annelida) has been employed as the test animal using the ethanolic extract of root bark of C. decidua Edgew because of its physical and physiological similarity to the roundworm parasite. When the extract utilized in the study was concentrated to a greater concentration of 100 mg/ml, the activity was discovered to be dose-dependent and similar with piperazine citrate (10 mg/ml). [36]

- *Carica papaya Linn.* (Family-Caricaceae)

Due to its morphological and physiological similarity to human intestinal round worm parasites, the anthelmintic activity of the adult Indian earthworm *Pheretima posthuma* was assessed.[37]In a different investigation, benzyl isothiocyanate, which was extracted from C. papaya Linn. seed extract, was identified as the main anthelmintic agent after being viability tested using Caenorhabditis worms.[38]

- *Erythrina indica Lam* (Family- Papilionaceae)

At concentrations of 50 mg/ml and 100 mg/ml, ethanol, chloroform, and ethyl acetate extracts of Erythrina indica leaves demonstrated considerable anthelmintic action against *Pheritima poshthuma*. By attaching to free protein in the host animal's gastrointestinal system or glycoprotein on the parasite's cuticle, tannins exerted anthelmintic action. By decoupling oxidative phosphorylation, phenolic substances (tannins are poly phenolic compounds) reduce the ability of helminth parasites to produce energy. A phytochemical examination of the leaves of the Erythrina indica plant identified tannins as one of the components. *Erythrina indica's* anthelmintic properties may result from one or both of the aforementioned mechanisms.[39]

- *Eucalyptus globulus* (Family Myrtaceae)

In accordance to the observations of the study by D. J. Taur, V. B. Kulkarni, and R. Y. Patil, albendazole took 5.82 0.46 and 6.54 0.429 minutes to paralyze and kill *P. posthuma*, while eucalyptus oil at an amount of 0.15 ml/ml takes 4.598 1.151 and 6.57 1.374 minutes to do the same. Therefore, the current study comes to the conclusion that E. globulus oil has anthelmintic potential since it contains phytoconstituents including borneol, linalool, cineol, geranyl acetate, anethol, and saffrol.[40]

- *Evolvulus alsinoides Linn.* (Family-Convolvulaceae)

As an effective aphrodisiac, anthelmintic, and brain stimulant, it is frequently used in Ayurveda. An ethanol-based extract of the whole plant was examined to validate its anthelmintic effect utilizing the adult Indian earthworms *Pheretima posthuma* as an experiment animal. The extract immobilized the worms at all dose levels that were tested before killing them. At a higher dosage of 100mg/ml, the ethanolic extract was found to be more effective than the reference control Piperazine citrate.[41]

- *Gynandropsis gynandra* (Family- Capparidacea)

For many years, plants from this family have been utilized in traditional African ethnomedicine, and different genera of plants have been documented for the treatment of various illnesses. The *G. gynandra* leaf methanol extract was highly toxic to earthworms. When compared to the reference medicine, which caused paralysis to last for 2 minutes and an 8-minute duration to death, respectively.[31]

- *Hugonia mystax* (Family- Linaceae)

Hugonia mystax leaves were dried for two weeks in the shade. Dried leaves were ground into a coarse powder, sieved (#40), and kept at room temperature in an airtight container. Then, dried powder was successively extracted with petroleum ether, chloroform, and ethanol utilizing soxhlation extraction. In this bioassay, anthelmintic activity of all prototypes were evaluated at doses of 25, 50, and 100 mg/ml. *Hugonia mystax* aerial parts' long-standing reputation as an anthelmintic was validated by the action of the extracts over *Pheretima posthuma*.[42]

- *Juglans regia L.* (Juglandaceae)

It was found that all of the Juglans regia extracts responded favourably to a specific level of anthelmintic activity. In comparison to the standard, acetone extract of plant material shows noticeable activity at all dilutions. The least effective of the four extracts is ethanol extract. More concentrated extracts have higher rates of death and paralysis. It indicates that compared to lower dosages, paralysis and death occur less frequently at greater concentrations. The crude extracts' phytochemical screening revealed the presence of flavonoids and polyphenolic compounds.[43] The tannins known as chemically polyphenolic substances have anthelmintic action.[44]

- *Melia azedarach Linn.*(Family-Meliaceae)

This species of tree, which is native to Persia, India, and China, has been used for centuries as a therapeutic and insect repellent herb all throughout the planet. Using piperazine phosphate as the reference medication, the ethanol-based extract of drupes was examined for its anthelmintic effectiveness against

both the tapeworm Taenia solium (Cestoda) & an earthworm called *Pheretima posthuma* (Annelida).Both the tested tapeworm and the earthworm were resistant to the extract. Furthermore, its efficacy against the tapeworm Taenia solium was superior compared to the use of piperazine phosphate.[45]

- *Mussaenda frondose* (Family- Rubiaceae)

The anthelmintic activity was carried out as per the method of Ajaiyeoba et al. This study has shown that the Mussaenda frondosa plant contains a large number of secondary metabolites (phytocostituents). The ability of the plant extract to combat and demonstrates how *Mussaenda frondosa* may be used to create novel, very effective anthelmintics.[46]

- *Murraya koenigii* (Family- Rutaceae)

Using various doses (12.5, 25, 50 mg/ml) for aqueous and methanolic extracts, which demonstrate to be dose-dependent, the in vitro investigation indicated anthelmintic impacts of *M. koenigii* against *Haemonchus contortus* as obvious due to its paralytic condition and/or mortality at eight-hour post treatment. Egg hatching was found to be only mildly inhibited by *M. koenigii* aqueous and methanolic extracts. *M. koenigii* shown strong anthelmintic activity, it can be said.[47]

- *Neolamarckia cadamba* (Family- Rubiaceae)

In accordance to the research, the extract caused the earthworms to die as well as be paralyzed. The greatest concentration of the methanolic extract demonstrated substantial anthelmintic activity since it caused paralysis and death more quickly than the medication albendazole did. It is possible that the terpenoids and phenolic chemicals in N. cadamba's fruit extract are what give it its anthelmintic properties. [48]

- *Nyctanthes arbor-tristis* (Family- Oleaceae)

The chloroform-methanol extract included flavonoids, whereas the methanolic portion revealed an inclusion of both tannins and flavonoids. The water-based extracts of Nyctanthes arbor-tristis consisted of steroid plus carbohydrate content. The biological components of Nyctanthes arbor-tristis have significant anthelmintic action, making them a potential replacement for routinely prescribed and expensive anthelmintic medications for the deworming of grazing animals.[49]

- *Punica granatum Linn.* (Family-Punicaceae)

It is grown all over India and is known locally as Anar. In the indigenous system of medicine, the plant's root and stem bark are employed as astringents and anthelmintics. Its stem bark's alcoholic extract was tested for its purported anthelmintic properties. It was discovered that the action was dose-dependent and prevented *Haemonchus contortus* eggs from developing into filariform larvae.[50]

- *Psidium guajava* (Family- Myrtaceae)

The testing of phytochemicals took place in accordance with accepted procedures. Minor adjustments were made to the Ajaiyeoba EO et al. procedure for the anthelmintic assay. Different extract concentrations were investigated in order to ascertain the experiment's worms' paralysis and death times. It was discovered that Psidium guajava leaf ethanol extract has strong anthelmintic activity at elevated concentrations (100 mg/ml). As a standard reference, albendazole in the same concentration as the extract was employed, and saline water served as the control. The results of the current studies support the ethno-medical assertion that this herb has anthelmintic properties. It can be included into medicine formulations and utilized in an alternate source for herbal anthelmintics.[51]

- *Spigelia anthelmia Linn* (Family- Loganiaceae)

Spigelia anthelmia Linn (Loganiaceae) is frequently used by locals in South Western Nigeria to get rid of worms. In South Western Nigeria, the Yoruba people refer to the plant as "Aparan," (apa-kill, araworm), and "ewearan."[52] *Spigelia anthelmia's* aqueous component had a respectable level of anthelmintic effectiveness. The extract's estimated median effective dose (ED50) was 21 mg/kg body weight. According to the therapeutic index found in this investigation, the extract is rather safe even at greater doses. This investigation verified *Spigelia anthelmia* Linn's anthelmintic properties. Additionally, rats exposed to the extract have considerable anthelmintic activity towards *Nippostrongylus braziliensis*.[53]

- *Spermacoce articularis* L.f. (Family- Rubiaceae)

Preliminary phytochemical analysis of the leaves and stem of *Spermacoce articularis* L.f. revealed the presence of tannins, flavonoids, carbs, the saponins steroids, and triterpenoids. The methanolic extracts of the leaves, stems, and roots demonstrated anthelmintic activity in a dosage-dependent manner; as the extracts' dose was raised, a progressive increase in anthelmintic activity was noticed. At maximal dosages of 100 mg/ml, all *Spermacoce articularis* L.f. extracts demonstrated considerable anthelmintic action in addition to paralysis. The results of this study have demonstrated the presence of anthelmintic activity in methanolic extracts of *Spermacoce articularis* L.f. leaves, stems, and roots at doses of 12.5, 25, 50, and 100 mg/ml.[54]

- *Trachyspermum ammi Linn.* (Family-Apiaceae)

The ajowan seeds are used as diuretics, analgesics, anthelmintics, and asthma medications.
The herb's seed extract was evaluated for its anthelmintic effect on sheep in one study, and it produced n oteworthy outcomes.[55]Using the egg hatch test (EHT) on *Haemonchus contortus* eggs , the ovicidal effectiveness of the crudeaqueous and methanolic extracts from T. ammi Linn. seeds were assess ed as well.The LC50 values forthese compounds were found to be 0.1698 and 0.1828 mg/ml, respectively. [56]

- *Trifolium repens Linn*. (Family-Fabaceae)

In Indian Naga tribal folk medicine, it is a deworming treatment. The anticestodal effectiveness of T. repens Linn. was evaluated utilizing testing *Hymenolepis diminuta* infections in albino rats. At doses of 200 and 500 mg/kg, the herb's aerial shoot extract reduced H. diminuta's mean fecal egg counts by 47.72 and 54.59% and its worm rate of recovery by 60 and 40%, respectively. The advised cestocidal drug, praziquantal, lowered the average fecal egg number by 65.90% & the worm rate of recovery by 26.67%.[57]

- *Trigonella foenum-graecum* (Family- Leguminoceae)

Trigonella foenum-graecum, a plant that is commonly referred to as fenugreek, is a member of the Leguminoceae family. The results of anthelmintic activity on the earthworm *Phertima prosthuma* demonstrate that various concentrations of both aqueous and alcoholic extracts caused the paralysis and death of earthworms when opposed to albendazole as a reference medicine at the exact same concentration. When compared to the identical concentration of standard drug, an alcoholic extract at a concentration of 60 mg/ml took somewhat longer to paralyze and slightly less time to kill earthworms.[58]

- *Zingiber officinale* (Family- Zingiberaceae)

Ginger (*Zingiber officinale*) is among the most often utilized plants whose anthelmintic abilities have been studied. In order to demonstrate the anthelmintic effects of Z. officinale rhizome on diverse parasite species, certain *in vitro* experiments as well as in vivo investigations have been conducted. In comparison to Mebendazole, this study shown that adding 25g/kg of ginger powder to pig feed is far better at lowering the overall parasite load of gastrointestinal nematodes.[59]

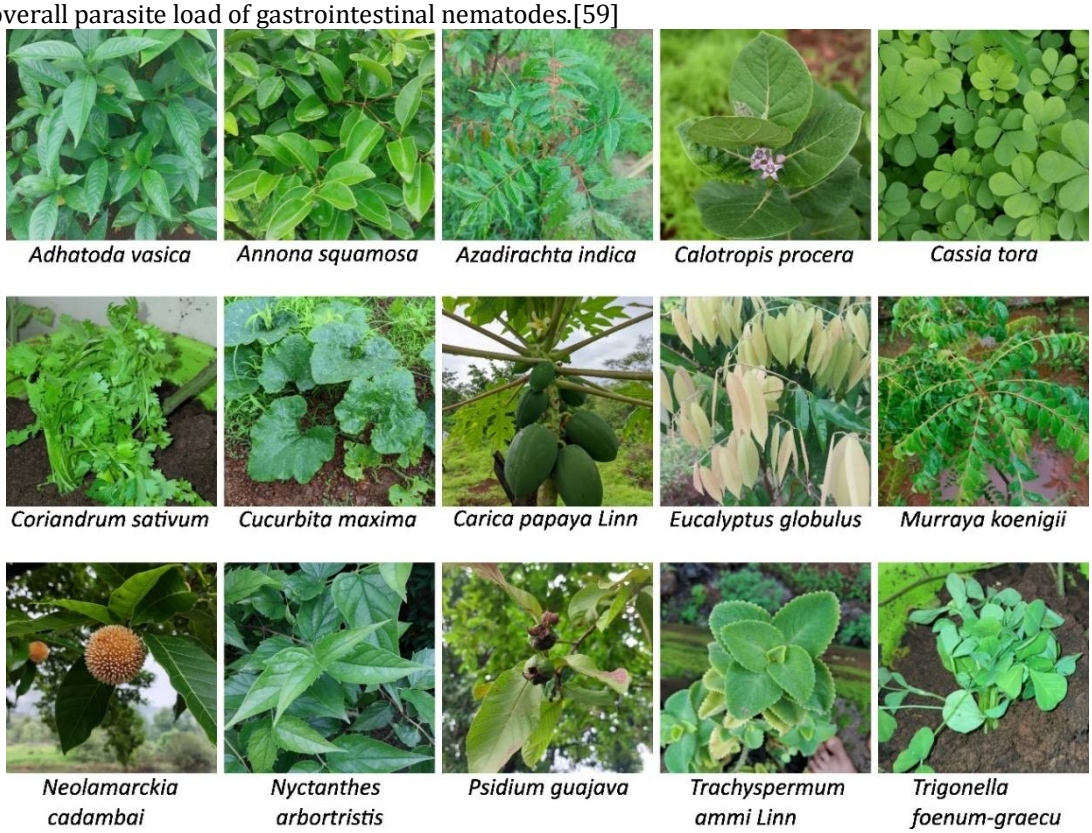

Figure1. Plants with proven anthelmintic property

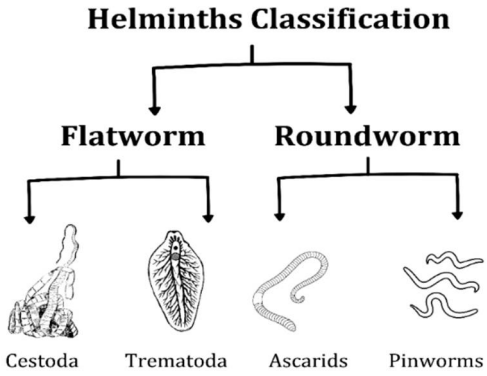

Figure2. Classification of Helminths

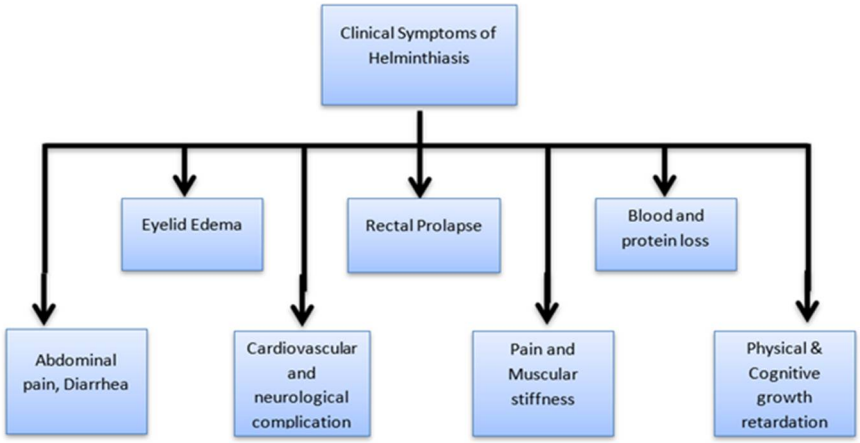

Figure3. Symptoms of anthelmintic infection[9]

CONCLUSION

In conclusion, helminthiasis is a prevalent and challenging disease caused by parasitic worms called helminths. It affects both humans and animals, causing a wide range of diseases and health complications. The misuse of drugs has led to the emergence of drug resistance, highlighting the need for the discovery of novel anthelmintic compounds.

Traditional medicinal plants have been extensively studied for their potential anthelmintic properties. Various plant species have demonstrated promising results in *in vitro* and *in vivo* studies, showing anthelmintic activity against different types of helminths. Some examples of these plants include *Adhatoda vesica, Aerva lanata, Azadirachta indica, Carica papaya*, *Cassia tora, Cucurbita maxima*, and many others. These plants contain bioactive compounds that have the potential to paralyze or kill the parasites, making them potential sources for the development of new anthelmintic drugs. Traditional medicinal plants offer a potential alternative or complementary approach to conventional anthelmintic drugs.

Different screening methods have been employed to study the anthelmintic activity of plant extracts, including tests on earthworms, hookworms, tapeworms, and other parasitic worms. In vitro assays measure factors such as paralysis and death of the worms, while *in vivo* experiments evaluate parameters like worm expulsion and reduction in the number of eggs.

Further research and exploration of these plant species and their bioactive compounds are needed to understand their mechanisms of action and develop safe and effective anthelmintic treatments. It is important to consider traditional knowledge, conduct rigorous scientific investigations, and ensure sustainable practices to harness the potential of medicinal plants in the fight against helminthiasis.

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