The Anthelmintic Potential of *Caesalpinia bonducella, Embelia ribes,* and *Ferula asafoetida* against Intestinal Worms

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Abstract

Helminth infections specifically caused by *Ascaris lumbricoides* and *Enterobius vermicularis* are major public health issues, especially in developing countries. School-age children and pregnant women are more susceptible to Ascariasis and Enterobiasis. Countries with inadequate sanitation and hygiene practices have more helminth infections. Resistance to synthetic anthelminthic drugs leads researchers to find alternative treatments derived from natural sources. Traditional herbal medicines provide an affordable medical treatment. This study will evaluate the anthelmintic activity of *Caesalpinia bonducella*, *Embelia ribes*, and *Ferula asafoetida* against intestinal worms. Bioactive molecules of these plants have been identified through phytochemical screening of the plant extracts. Plant extracts have been used against intestinal worms isolated from human fecal samples. This in vitro study shows the anthelmintic efficacy of these plants. This study will provide significant insight into antiparasitic properties of extracts of *F. Asafoetida*, *C. bonducella, and E. ribes*, conceivably remedying solutions for combating helminths in humans and resolving problems related to drug resistance.

Keywords: Leukopenia, *Ascaris lumbricoides*, Antispasmodic, Rhamnose

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Introduction

Globally, infections caused by intestinal parasites represent a major challenge to public health. (Zeynudin et al., 2024). Annually, intestinal parasites affect roughly 3.5 billion people worldwide, resulting in over 450 million instances of illness (Alkholy et al., 2024). Soil-transmitted helminth (STH) infections primarily impact disadvantaged communities that lack reliable access to safe water, proper sanitation, and adequate hygiene (Krishnaraju et al., 2024). The 2019 Global Burden of Disease (GBD) report estimates that soil-transmitted helminth infections result in the loss of about 1.5 million disability-adjusted life years (DALYs) (Agrawal et al., 2024). Three main types of parasitic worms can infect humans: Nematodes (roundworms), Cestodes (tapeworms), and Trematodes (flukes) (Woodruff, 1952; Narahari et al., 2016). In this chapter, we will focus on Ascaris lumbricoides and Enterobius vermicularis.

In both aquatic and terrestrial environments, helminths can exist as parasites or live independently (Hedley & Wani, 2015). Helminths are a significant cause of morbidity and mortality (Liyanage, 2022). The untreated use of domestic wastewater for irrigation and sludge disposal is happening every day in developing countries, promoting the spread of helminth eggs, the infectious stage of intestinal worms (Maya et al., 2019). The warm and humid climate of tropical and subtropical regions creates an ideal environment for the survival of soil-transmitted helminth (STH) eggs or larvae (Veer & Kharade, 2019).

Helminthiasis is a significant issue, resulting in the prevalence of anemia, malnutrition, pneumonia, and eosinophilia (Zangueu et al., 018), severe side effects such as impaired physical and mental development, and diarrhea, particularly in children aged 5 to 15 years (Maya et al., 2019). Anemia and deficiencies in essential micronutrients, including iron, vitamins, and folate, can result in decreased physical performance, impaired cognitive abilities, and complications during pregnancy (Liyanage, 2022). Infections commonly occur through ingestion of parasite eggs or contact with fecally contaminated soil, primarily via fecal-oral transmission (Aemiro et al., 2024). Foodborne parasitic infections are linked to consuming contaminated fresh vegetables, especially when eaten raw or unpeeled, which can easily transmit parasites (Zeynudin et al., 2024). The World Health Organization (WHO) identifies preschool-aged children, school-aged children, and women of reproductive age (Aemiro et al., 2024), plantation laborers, and agricultural workers as high-risk groups.

Soil-transmitted helminths lead to mental impairments to malnutrition while also reducing the child's ability to tackle other pathogens. In children, acute Ascariasis can cause intestinal obstruction (Olaniran et al., 2015). Soil-transmitted helminth infections can become more severe, particularly among individuals with weakened immune defenses (Agrawal et al., 2024).

1. Diagnostic Methods

The current diagnostic method for soil-transmitted helminths (STHs) involves manually examining stool samples under a microscope to identify and count parasites or their eggs (Lundin et al., 2024). Various diagnostic methods have been evaluated, including wet-mount, flotation-based techniques (FLOTAC, Mini-FLOTAC, FECPAKG2, McMaster), and DNA-based methods (qPCR, LAMP). These offer higher sensitivity and specificity but have drawbacks like high cost, time consumption, and the need for specialized equipment. Due to its simplicity and reliability, WHO still recommends manual Kato-Katz microscopy for epidemiological surveys (Lundin et al., 2024).

2. Overview of *Ascaris lumbricoides* and *Enterobius vermicularis*

The most common soil-transmitted helminths (STH) infecting humans are *Ascaris lumbricoides*, *Trichuris trichiura*, and *Ancylostoma duodenale* (Belga et al., 2024), *Necator americanus* (Lundin et al., 2024), and *Enterobius vermicularis* (Zbida et al., 2025) It is a small, whitish nematode (Pezzani et al., 2004) commonly known as pinworm, affects approximately 200 million people globally, with children being the most affected (Chaibutr et al., 2024).

E. vermicularis exclusively infects humans and causes *enterobiasis* (Zbida et al., 2025). The presence of *E.* vermicularis in appendix linked with anal fissures, bowel obstruction, anal itching and rapid severe appendicitis and secondary infections (Ponniah et al., 2025). Medically, patients with Enterobiasis are asymptomatic, but can have perianal itching, because the female worm lays eggs at night. Larvae become infective. The eggs are work-intensive and less sensitive (Tong et al., 2011). Infection spreads via the fecal-oral route through direct contact with an infected individual. It can also occur through autoinfection when a patient's hands become contaminated with *E. vermicularis* eggs. Additionally, transmission may take place through the inhalation of dust or aerosols containing the eggs (Zbida et al., 2025). Mostly helminth infections are asymptomatic, but sometimes they can have severe symptoms, and sometimes even fatal (Cambra-Pellejà et al., 2025)

Ascariasis is a widespread health concern, particularly in developing nations, affecting a significant portion of the global population (Sundarka & Sundarka, 2025). *Ascariasis* is a major cause of intestinal blockage in children, where a high worm burden can partially or fully obstruct the intestine, leading to acute abdominal symptoms (Jayakody et al., 2024) i.e., lower abdominal pain, stunted growth, malnutrition, and gastrointestinal disturbance (Lebu, 2023). Ascariasis can lead to death when intestinal obstruction occurs (Andrade et al., 2015; Turyasiima et al., 2021). According to the World Health Organization (WHO), preschool children are at high risk for Ascariasis in local areas (Gizaw et al., 2019). Infection occurs when mature eggs are ingested, often through contaminated food, particularly raw or unwashed vegetables (Woodruff, 1952). Once hatched, the larvae enter the bloodstream and travel to the lungs, where they are eventually coughed up, swallowed, and returned to the digestive system. The parasites reach maturity in the small intestine, and their life cycle continues when eggs are excreted in feces and released into the soil (Krishnaraju et al., 2024).

3. Conventional Anthelmintic Treatments and Their Limitations

Since these infections are associated with limited access to clean water, inadequate personal hygiene, low economic conditions, and poor sanitation, preventive measures such as wearing protective gloves and footwear during outdoor activities, along with enhancing water quality, sanitation, and hygiene, can serve as effective strategies for prevention and control (Krishnaraju et al., 2024). Recent methods to minimize the effects of STH infections are mass drug administration (MDA) programs that include the use of synthetic drugs, such as mebendazole and albendazole, to vulnerable populations in local regions (Imoro et al., 2025). The medication includes two doses of albendazole or mebendazole, which are derivatives of benzimidazole having both egg-killing and adult-killing qualities, making them successful (Wong et al., 2025). Chemotherapy continues to be the primary approach for managing all gastrointestinal parasites (Liyanage, 2022). Surgical removal makes sure total elimination of symptoms and also minimizes the risk of fibromyalgia and permits microscopic examination (Ponniah et al., 2025). For the treatment of STH, various chemically synthetic drugs are present in the market, but nowadays, people are looking forward to the use of more and more natural-origin drugs, as most of the modern synthetic drugs and medicines have attacked the targets blindly and thus badly affected several related metabolic processes (Veer & Kharade, 2019).

The excessive use of anti-parasitic drugs has resulted in the global emergence of anthelmintic resistance (Belga et al., 2024). These drugs cause unpleasant side effects, including a bad taste in the mouth, indigestion, nausea, headaches, and leukopenia. Additionally, some may lead to neurotoxicity, restlessness, seizures, and dizziness, potentially interfering with treatment. They also pose risks of mutagenic and carcinogenic effects and other adverse reactions (Hariri & Garedaghi, 2024). The long-term use of metronidazole can lead to side effects such as nausea, dry mouth, headache, metallic taste, and glossitis (Ranasinghe et al., 2023a). Due to strong selection pressure and genetically distinct parasite populations, anthelmintic resistance develops speedily (Ahmed et al., 2023).

4. Ethnomedical Importance of Medicinal Plants

A variety of herbal medicines have been used since the old days to treat helminth infections (Al-Olayan et al., 2024)for the treatment of specific long-term and severe diseases and disorders (Veer & Kharade, 2019).

5. Phytochemical Profile of Selected Plants

Plant and plant products, their biologically active substances, and their purified extracts have been continuously studied because of their reinitiated health effects, mostly used for ethnomedicine and many other uses (Bagheri et al., 2016; Sharifi et al., 2018; Salehi et al., 2018; Mishra et al., 2018). In science and medicine, medicinal plants are obtaining significant recognition (Sharifi et al., 2018). In developing countries, about 80% of the population relies on medicinal plants according to the World Health Organization (WHO). As plant-based medicines provide cost-effective treatment, mainly due to low convince to medical facilities, the effect of traditional priorities, established efficacy, and culture (Aziz et al., 2018).

Due to toxic effects and drug reactions, man-made drugs are easily available and have often been negatively pointed out (Martins et al.,

2016). The bioactive molecules isolated from plants and animals are extracted from their biologically active substances, used in therapeutic formulation (Sharifi et al., 2017).

Vedanga (*Embelia ribes)*, also known as false black pepper, for the treatment of various infections is used in traditional Indian medicines (Boini et al., 2023). Due to its activating and anthelmintic properties, dried fruits of this plant are typically recognized. An infection, Ascariasis, which is caused by *A. lumbricoides*, *E. ribes*, is recognized for its treatment (Singh, 2015). For the treatment of skin infections and intestinal worms, it is widely used (Nagamani et al., 2013). *E. ribes* fruit powder showed moderate yet promising anthelmintic activity without side effects, attributed to its bioactive compounds, embolic acid or embelin . The plant is widely known for its anthelmintic, carminative, antibacterial, anti-inflammatory, diuretic, and astringent properties, as reported in various studies (Kekuda et al., 2009).

E. ribes has been used in traditional medicine for over 5,000 years. Its benefits include: blood detoxification, aiding in various skin diseases, contraceptive effects when combined with Pippali, enhancing skin complexion and rejuvenation, water decoction for oil pulling, relieving dental caries and bad breath, oral and topical use for skin conditions, Mild diuretic properties, relief from vomiting, bloating, indigestion, gastritis, and constipation, commonly used in weight loss treatments (Souravi & Rajasekharan, 2014). Embelin has been analyzed by previous researchers by HPLC to determine its barriers (Nagamani et al., 2013). The polar solvent extraction of *E. ribes* has a higher recovery than extraction with nonpolar solvents (Latha et al., 2007).

Ferula asafoetida, commonly referred to as asafoetida, belonging to the family Umbelliferae, is an oleo-gum-resin obtained from the stems of Ferula species (Menariya et al., 2024). Being strong, sulfurous odor, and persistent, *F. asafoetida* has significant medicinal and nutritional value (Javaid et al., 2020). Antiparasitic activity of F. asafoetida is studied by various researchers *(Arbabi M et al., 2024)*.

F. asafoetida has been used in many countries for its helminthicide properties for centuries (Tavassoli et al., 2018). Respiratory infection, helminth infections, influenza, abdominal pain, lung inflammation, stomach upset, spasms, and stomach ulcers. *F. asafoetida* has been used especially for the treatment of intestinal infections (Menariya et al., 2024). *F. asafoetida* has been described for several properties, such as a dehydrating agent, antispasmodic, menstrual enhancer, gas reducer, sensual enhancer, fluid reducer, antitussive, anthelmintic antitoxin, appetizer, germicide, palliative, necrotic, fever reducer, voice purifier, and bowl stimulant (Javaid et al., 2020). Rhamnose, galactose, polysaccharides, N1-arabinose glycoproteins, glucose, glucuronic acid are present in gum of *F. asafoetida,* and the mercurial portion comprises monoterpenes, sulfur-containing compounds, and other volatile terpenoids (Iranshahy & Iranshahi, 2011)

Caesalpinia bonducella belongs to the family Caesalpiniaceae, having hard yellow spikes with a climbing shrub. (Dongre et al., 2012). The parts of Caesalpinia are utilized in traditional medicinal practices, and they have significant medicinal value (Muthuswamy et al., 2024). Seeds of C. bonducella have chemical compounds such as carbohydrates, fatty acids, amino acids, β-sitosterol, gums, furanocoumarins, diterpenes, β-carotene, glycosides, bonducellin, and phytosterolin. (Dongre et al., 2012). It possesses many pharmacological activities, including hepatoprotective, adaptogenic, anti-inflammatory, anthelmintic, antifilarial, analgesic, antifertility effects, antioxidant, hypoglycemic, immunomodulatory, antimalarial, and antipyretic (Muthuswamy et al., 2024). Extracts of *C. bonducella* show considerable antiparasitic effect (Gogoi & Yadav, 2016).

Conclusion

The prevalence of ascariasis and enterobiasis is linked to living standards and public health measures, highlighting the critical necessity for cost-effective and different healing methods. This research will act as a bridge between cultural knowledge and experimentally proven knowledge. For two important intestinal parasites in humans *A. lumbricoides and E. vermicularis E. ribes, C. bonducella* and of *F. asafoetida* shows anthelmintic potential. It will reveal the mechanism through which these three medicinal plants exert their antiparasitic activity on specific nematodes. Phytochemical analysis of these medicinal plants shows that various bioactive compounds may have antiparasitic effects. According to the researcher *E. ribes, F. asafoetida* and *C. bonducella* offer a safe and eco-friendly solution for intestinal infections because they serve as a natural alternative to synthetic drugs. Future studies, confirm their potential and safety for therapeutic use, including health assessments and in vivo trials. To improve public health, this study supports and explores the plant-based anthelmintic agents and the significance of herbal medicines.

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