OPEN ACCESS

Saudi Journal of Medical and Pharmaceutical Sciences
Abbreviated Key Title: Saudi J Med Pharm Sci
ISSN 2413-4929 (Print) | ISSN 2413-4910 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article **Pharmacology**

In Vitro Anthelmintic Activity of Successive Soxhlet Extracts of *Streblus Asper* Lour. (Moraceae) Leaves Against *Pheretima Posthuma*: Phytochemical Characterization and Mechanistic Insights

Sujan Mandal[1*], Dipanjali Boruah[1], Khalid Md Ariful Islam[1], Bikash Saikia[1]

[1]Department of Pharmacology, NEPEDS College of Pharmaceutical Sciences, Tetelia, Khetri, Maloibari Pathar, Assam 782403 India

DOI: https://doi.org/10.36348/sjmps.2026.v12i05.008 | **Received:** 05.04.2026 | **Accepted:** 21.05.2026 | **Published:** 21.05.2026

***Corresponding author:** Sujan Mandal
Department of Pharmacology, NEPEDS College of Pharmaceutical Sciences, Tetelia, Khetri, Maloibari Pathar, Assam 782403 India

Abstract

Introduction: *Streblus asper* Lour. (Moraceae), known locally as Sheora or Khoi, has been traditionally used across South and Southeast Asian medicine systems including Ayurveda and folk practices in Assam, India for the treatment of intestinal worm infestations, filariasis, and gastrointestinal disorders. Despite this well-documented ethnopharmacological background, systematic in vitro evaluation of its anthelmintic potential using standardized bioassay models remains inadequate in the published literature. ***Aim of the study:*** To evaluate the in vitro anthelmintic activity of successive Soxhlet-derived chloroform, ethyl acetate, and hydroalcoholic (70% ethanol) leaf extracts of *S. asper* against *Pheretima posthuma*, using albendazole as a positive control, and to characterize the phytochemical profile of each extract. ***Materials and methods:*** Dried leaf powder (100 g) of *S. asper*, authenticated by voucher specimen (SA/BOT/2026/01), was subjected to successive Soxhlet extraction with chloroform, ethyl acetate, and 70% ethanol. Each extract was characterized by qualitative phytochemical screening. Anthelmintic activity was assessed using adult *P. posthuma* earthworms (n = 6 per group) at concentrations of 10, 20, and 40 mg/mL by recording time to paralysis (TP) and time to death (TD) at 37 ± 0.5°C. Data were analysed by one-way ANOVA with Tukey's post hoc test ($p < 0.05$). ***Results:*** Extract yields were 3.12% (chloroform), 4.56% (ethyl acetate), and 8.84% (ethanolic) w/w. The ethanolic extract tested strongly positive for tannins, saponins, flavonoids, alkaloids, and cardiac glycosides. All three extracts produced dose-dependent anthelmintic activity ($p < 0.001$ vs. negative control). At 40 mg/mL, the ethanolic extract produced paralysis in 23.40 ± 0.82 min and death in 39.60 ± 0.98 min, compared to albendazole at 16.00 ± 0.58 min and 27.80 ± 0.74 min, respectively. Potency ranking at all doses: albendazole > ethanolic > ethyl acetate > chloroform extract. ***Conclusions:*** The hydroalcoholic leaf extract of *S. asper* exhibits significant anthelmintic activity attributable to the synergistic action of tannins, saponins, flavonoids, and cardiac glycosides. These findings provide rigorous pharmacological substantiation for the ethnomedicinal use of this plant as an anthelmintic and identify it as a promising candidate for further bioactivity-guided fractionation and in vivo validation.

Keywords: Streblus asper; anthelmintic; Pheretima posthuma; Soxhlet extraction; tannins; saponins; ethnopharmacology; Moraceae.

1. INTRODUCTION

Helminthiasis remains one of the most prevalent and debilitating groups of parasitic diseases globally. The World Health Organization estimates that over 1.5 billion people nearly one-fifth of the global population are currently infected with soil-transmitted helminths (STHs), with the greatest burden concentrated in tropical and subtropical regions including sub-Saharan Africa, Southeast Asia, and South Asia (World Health Organization [WHO], 2023). In India, STH infections disproportionately affect children, pregnant women, and rural communities with limited access to clean water and sanitation (Hotez *et al.,*2008). Beyond direct morbidity, helminthic infections impose enormous indirect burdens through malnutrition, growth retardation, cognitive impairment, and loss of economic productivity (Bethony *et al.,*2006).

Current anthelmintic chemotherapy relies on a narrow pharmacological portfolio comprising benzimidazoles (albendazole, mebendazole),

levamisole, pyrantel pamoate, praziquantel, and ivermectin. These drugs act through distinct mechanisms: benzimidazoles inhibit microtubule polymerization; levamisole and pyrantel act as nicotinic acetylcholine agonists producing spastic paralysis; praziquantel increases calcium permeability; and ivermectin potentiates glutamate-gated chloride channels causing flaccid paralysis (Geary, 2012). Despite their established efficacy, the long-term viability of these agents is increasingly threatened by documented and emerging drug resistance particularly reduced cure rates of albendazole and mebendazole against *Trichuris trichiura* alongside adverse effects, contraindications in pregnancy, and cost-related access barriers in resource-limited settings (Prichard *et al.,*2012). These compounding limitations underscore the urgent scientific imperative to identify novel anthelmintic agents from accessible, safe, and affordable sources.

Plants represent one of the most historically validated and pharmacologically diverse reservoirs of antiparasitic compounds. Secondary metabolites including tannins, saponins, flavonoids, alkaloids, and terpenoids have been documented to exert anthelmintic effects through mechanisms ranging from cuticle disruption and neuromuscular blockade to inhibition of helminth-specific mitochondrial enzymes (Athanasiadou *et al.,*2001; Hoste *et al.,*2006). Traditional medicine systems in South and Southeast Asia, including Ayurveda, Siddha, and folk practices of northeastern India, hold extensive documented knowledge of plant-based anthelmintic remedies that remain largely unexplored in systematic pharmacological studies.

Streblus asper Lour. (Moraceae), commonly known as Sheora (Hindi), Shakhotaka (Sanskrit), or Khoi (Thai), is a small evergreen tree distributed widely across India, Sri Lanka, Bangladesh, Nepal, Thailand, and other parts of Southeast Asia. In Ayurvedic medicine it is classified as *Shakhotaka* and prescribed for the treatment of filariasis, intestinal worm infestations, diarrhea, leprosy, and skin diseases (Chopra *et al.,*1956; Warrier *et al.,*1994). Among tribal communities of Assam and Odisha, preparations of *S. asper* are used by traditional healers specifically for worm infestations in both humans and livestock (Jain, 1991). Phytochemical investigations have identified the presence of cardiac glycosides (strebloside, asperoside, kamloside), tannins (gallic acid, ellagic acid), flavonoids (luteolin, quercetin, kaempferol derivatives), saponins, and sterols (beta-sitosterol, stigmasterol) as major secondary metabolite classes (Singh *et al.,*2011; Murti *et al.,*2012). Published studies have documented antimicrobial (Murti *et al.,*2012), anti-inflammatory (Singh *et al.,*2011), antifilarial (Sahare *et al.,*2008), antidiarrheal (Kumar *et al.,*2010), and cytotoxic (Balachandran *et al.,*2005) activities of various *S. asper* extracts.

Despite this substantial pharmacological background and rich ethnobotanical record, a systematic, concentration-dependent in vitro evaluation of the anthelmintic potential of *S. asper* leaf extracts using a validated bioassay model and standardized positive control remains unreported or insufficiently documented in the peer-reviewed literature. The present study was therefore designed to: (i) prepare successive Soxhlet extracts of *S. asper* leaves using solvents of increasing polarity (chloroform, ethyl acetate, 70% ethanol); (ii) characterize their preliminary phytochemical profiles; and (iii) evaluate their in vitro anthelmintic activity against *Pheretima posthuma* at multiple concentrations, with albendazole as positive control, to establish pharmacological evidence supporting the traditional anthelmintic use of this plant.

2. MATERIALS AND METHODS

2.1 Plant material collection and authentication

Fresh, mature leaves of *Streblus asper* Lour. were collected during October–November from the local forest areas of Kokrajhar district, Assam, India (26.4021° N, 90.2706° E). The plant was authenticated by a qualified botanist at the Department of Botany based on established morphological descriptors including the distinctly scabrid (rough) adaxial leaf surface, serrate margins, ovate-oblong lamina, and milky latex, as described in standard Indian flora references (Kirtikar & Basu, 1935; Warrier *et al.,*1994). A voucher specimen (No. SA/BOT/2024/01) was deposited in the Departmental Herbarium.

2.2 Preparation of plant material

Freshly collected leaves were washed with running tap water and rinsed with distilled water. Leaves were shade-dried at ambient temperature (25–30°C) for 14–21 days away from direct sunlight until constant weight was achieved. The dried material was mechanically powdered and passed through mesh sieve No. 40 to obtain uniform coarse powder. Moisture content (loss on drying at 105°C) was determined as 7.2% w/w, within the pharmacopoeial limit (<10%). A total of 100 g of dried leaf powder was used as starting material.

2.3 Successive Soxhlet extraction

Successive Soxhlet extraction was performed using solvents of increasing polarity: chloroform (boiling point 61°C), ethyl acetate (bp 77°C), and 70% ethanol (bp ~78°C). In each stage, the plant material (or marc from the preceding stage) was loaded into Whatman cellulose extraction thimbles (No. 603) and extracted using 300 mL of the respective solvent until the solvent in the extractor body appeared colorless (6–10 hours per stage). Extracts were concentrated to dryness using a rotary vacuum evaporator (Buchi R-215) at 40–50°C under reduced pressure. Percentage yield (w/w) was calculated as: % yield = (weight of dried extract / weight of starting material) × 100. Dried extracts were stored in airtight amber vials at 4°C.

2.4 Preliminary phytochemical screening

Each extract was subjected to standard qualitative phytochemical tests for detection of alkaloids (Mayer's, Wagner's, Dragendroff's tests), flavonoids (Shinoda's test), tannins and phenolics (ferric chloride, lead acetate tests), saponins (froth test), sterols and triterpenoids (Salkowski's, Liebermann-Burchard tests), cardiac glycosides (Legal's test), carbohydrates (Molisch's test), reducing sugars (Benedict's test), and amino acids (ninhydrin test), following standard protocols described by Trease and Evans (2002) and Harborne (1998).

2.5 Experimental model

Adult *Pheretima posthuma* earthworms (Megascolecidae) of uniform size (3–5 cm length, 0.1–0.3 g weight) were procured from locally collected moist agricultural soil of Kokrajhar district, Assam. Worms showing vigorous spontaneous sinusoidal locomotion were selected; those exhibiting injury, sluggishness, or anomalous pigmentation were excluded. All worms were washed in normal saline (0.9% w/v NaCl) prior to use. The *P. posthuma* model is anatomically and physiologically analogous to gastrointestinal nematodes, is well-validated for preliminary anthelmintic screening, and is ethically acceptable as an invertebrate model (Ajaiyeoba *et al.,* 2001; Dash *et al.,*2002).

2.6 In vitro anthelmintic assay

Stock solutions of each extract were prepared by dissolving accurately weighed quantities in DMSO (≤1% v/v final concentration) and diluting with phosphate buffered saline (PBS, pH 7.4) to yield working concentrations of 10, 20, and 40 mg/mL. Albendazole (IP reference standard) was prepared identically at the same concentrations as positive control; distilled water (1% DMSO) served as negative control. Six adult earthworms per group were individually placed in Petri dishes (9 cm diameter) containing 20 mL of the respective solution and incubated at 37 ± 0.5°C. The following endpoints were recorded using a digital stopwatch: (i) Time to paralysis (TP): complete cessation of spontaneous locomotion, confirmed by inability to resume movement within 10 s of transfer to normal saline; (ii) Time to death (TD): irreversible cessation of all movement with progressive loss of body turgor, fading of body color, and no response to tactile stimulation or brief immersion (5 s) in warm water at 50°C. The assay protocol followed Ajaiyeoba *et al.,* (2001) as modified by Dash *et al.,* (2002).

2.7 Statistical analysis

Data are expressed as Mean ± Standard Error of the Mean (SEM) of six independent replicates (n = 6) per group. Statistical analysis was performed using one-way ANOVA. $p < 0.05$ was considered statistically significant.

3. RESULTS

3.1 Extract yield and macroscopic characteristics

Successive Soxhlet extraction of 100 g of dried *S. asper* leaf powder yielded extracts of increasing quantity corresponding to increasing solvent polarity (Table 1). The chloroform extract was dark green with waxy consistency; the ethyl acetate extract was yellowish-brown and semi-solid; and the ethanolic extract was dark brownish-black, hygroscopic, and highly viscous consistent with its enriched polar phytoconstituent content. The highest yield was obtained with the ethanolic solvent (8.84% w/w), followed by ethyl acetate (4.56% w/w) and chloroform (3.12% w/w).

Table 1: Percentage yield of successive Soxhlet extracts of *Streblus asper* Lour. leaves (starting material: 100 g dried leaf powder)

Extract	Solvent	Weight of Extract (g)	Yield (% w/w)
Chloroform extract	Chloroform	3.12	3.12
Ethyl acetate extract	Ethyl acetate	4.56	4.56
Ethanolic extract	70% Ethanol	8.84	8.84

3.2 Preliminary phytochemical screening

Qualitative phytochemical screening revealed a polarity-dependent distribution of secondary metabolites across the three fractions (Table 2). The ethanolic extract tested strongly positive for tannins/phenolics, saponins, flavonoids, cardiac glycosides, reducing sugars, and carbohydrates, and positive for alkaloids, sterols/triterpenoids, and amino acids. The ethyl acetate extract was positive for alkaloids, flavonoids, tannins, saponins, sterols, and cardiac glycosides. The chloroform extract was strongly positive for sterols/triterpenoids and cardiac glycosides, and positive for alkaloids by Mayer's and Wagner's tests, but negative for tannins, saponins, and flavonoids consistent with the polar character of these constituents. Anthraquinones were absent in all three extracts.

Table 2: Qualitative phytochemical profile of successive Soxhlet extracts of *Streblus asper* Lour. leaves.

Phytoconstituent	Ethanolic Extract	Ethyl Acetate Extract	Chloroform Extract
Alkaloids	++	+	+
Flavonoids	++	+	−
Tannins / Phenolics	++	+	−
Saponins	++	+	−
Sterols / Triterpenoids	+	+	++

Cardiac Glycosides	++	++	++
Carbohydrates	++	++	+
Reducing Sugars	++	+	−
Amino Acids / Proteins	+	−	−
Anthraquinones	−	−	−
++ = Strongly present; + = Present; − = Absent.			

3.3 In vitro anthelmintic activity

Earthworms in the negative control (distilled water) exhibited continuous vigorous sinusoidal locomotion throughout the 120-minute observation period, confirming model integrity. All three *S. asper* Soxhlet extracts and albendazole produced dose-dependent anthelmintic effects, with one-way ANOVA confirming highly significant differences ($p < 0.001$) between all treatment groups at each concentration. Mean TP and TD values are presented in Table 3.

At 40 mg/mL the highest concentration tested the ethanolic extract produced TP of 23.40 ± 0.82 min and TD of 39.60 ± 0.98 min. This compares to TP 16.00 ± 0.58 min and TD 27.80 ± 0.74 min for albendazole at the same concentration. The potency order at all concentrations was: albendazole > ethanolic extract > ethyl acetate extract > chloroform extract. Tukey's post hoc analysis confirmed that the ethanolic extract was statistically significantly more potent than both the ethyl acetate ($p < 0.01$) and chloroform ($p < 0.001$) extracts at all concentrations tested. The ethanolic extract's activity at 40 mg/mL was approximately 1.46-fold slower than albendazole for TP, and 1.42-fold slower for TD a clinically meaningful margin for a crude plant extract. A brief transient hyperkinetic phase (2–5 min) was observed in earthworms exposed to the ethanolic and ethyl acetate extracts before progressive locomotor inhibition occurred consistent with initial membrane-irritant effects of saponins and tannins preceding neuromuscular disruption. The chloroform group showed a more gradual onset without this hyperkinetic phase.

Table 3: *In vitro* anthelmintic activity of successive Soxhlet extracts of *Streblus asper* Lour. leaves and albendazole against *Pheretima posthuma*. Values are Mean ± SEM (n = 6)

Treatment Group	Concentration (mg/mL)	Time to Paralysis (min) Mean ± SEM	Time to Death (min) Mean ± SEM
Negative Control (Distilled Water)	—	No paralysis	No death
Albendazole	10	37.80 ± 0.82	57.60 ± 1.12
Albendazole	20	26.20 ± 0.76	43.40 ± 0.94
Albendazole	40	16.00 ± 0.58	27.80 ± 0.74
Ethanolic Extract	10	51.60 ± 1.08	77.40 ± 1.42
Ethanolic Extract	20	37.80 ± 0.92	59.20 ± 1.24
Ethanolic Extract	40	23.40 ± 0.82	39.60 ± 0.98
Ethyl Acetate Extract	10	62.20 ± 1.28	90.60 ± 1.58
Ethyl Acetate Extract	20	47.80 ± 1.14	73.40 ± 1.34
Ethyl Acetate Extract	40	33.60 ± 1.02	53.80 ± 1.18
Chloroform Extract	10	73.60 ± 1.52	107.80 ± 2.06
Chloroform Extract	20	57.80 ± 1.28	87.40 ± 1.82
Chloroform Extract	40	44.20 ± 1.10	67.60 ± 1.54

All extract groups were statistically significant vs. negative control ($p < 0.001$, one-way ANOVA, Tukey's HSD)

4. DISCUSSION

The present study provides systematic, pharmacological evidence for the in vitro anthelmintic activity of successive Soxhlet-derived leaf extracts of *Streblus asper*, an ethnomedicinally important plant from the family Moraceae that has been used for centuries in Ayurveda and northeastern Indian folk medicine as a remedy for intestinal worm infestations (Chopra *et al.,*1956; Jain, 1991). This represents, to the best of our knowledge, the first systematic, multi-concentration comparison of solvent-fractionated *S. asper* leaf extracts in the validated *Pheretima posthuma* anthelmintic bioassay.

The progressive increase in extract yield with solvent polarity (3.12% chloroform < 4.56% ethyl acetate < 8.84% ethanolic) is consistent with the known predominance of polar secondary metabolites tannins, saponins, flavonoids, glycosides in the leaves of *S. asper*, as previously reported by Singh *et al.,* (2011) and Murti *et al.,* (2012). Phytochemical screening confirmed the polarity-selective distribution of these constituents: tannins, saponins, and flavonoids were restricted to the polar fractions, while sterols and triterpenoids were most prominent in the non-polar chloroform fraction. Cardiac glycosides (strongly positive by Legal's test in all three fractions) corroborate the well-documented presence of

strebloside and asperoside throughout *S. asper* tissues (Hänsel *et al.,*1965; Balachandran *et al.,*2005).

The dose-dependent anthelmintic activity of all three extracts with potency order albendazole > ethanolic > ethyl acetate > chloroform at all concentrations mirrors the pattern of pharmacologically active phytoconstituent distribution across the fractions. The superior activity of the ethanolic extract is mechanistically attributable to the synergistic action of its diverse polar phytoconstituents. Tannins form stable complexes with surface glycoproteins of the helminth cuticle, disrupting membrane integrity and impairing nutrient absorption (Athanasiadou *et al.,*2001). Saponins function as membrane pore-forming agents that intercalate into helminth plasma membranes, dissipating electrochemical gradients essential for neuromuscular function (Hoste *et al.,*2006). Flavonoids particularly luteolin and quercetin derivatives documented in *S. asper* by Singh *et al.,*(2011) are known inhibitors of fumarate reductase, the key mitochondrial enzyme of nematode anaerobic energy metabolism (Athanasiadou *et al.,*2007). Additionally, the cardiac glycosides strebloside and asperoside inhibit Na^+/K^+-ATPase in helminth tissues, disrupting ionic homeostasis and membrane potential a mechanism established for *S. asper* constituents by Balachandran *et al.,*(2005) in the context of cytotoxic activity. The simultaneous concentration of all four mechanism-relevant compound classes in the ethanolic fraction, achieved through exhaustive Soxhlet extraction, likely underlies its potent and reproducible anthelmintic activity.

The ethanolic extract at 40 mg/mL achieved TP of 23.40 ± 0.82 min approximately 1.46-fold slower than albendazole (16.00 ± 0.58 min) and TD of 39.60 ± 0.98 min versus 27.80 ± 0.74 min for albendazole, at the same concentration. This activity is pharmacologically comparable to previously validated tannin-rich plant anthelmintics: Parekh and Chanda (2007) reported TP of approximately 22 min and TD of approximately 38 min for *Terminalia chebula* at 40 mg/mL, and Nath *et al.,* (2009) documented TP of 17.2 ± 0.5 min and TD of 35.4 ± 1.2 min for *Artocarpus lakoocha* (Moraceae) at the same concentration. The finding that the ethanolic *S. asper* extract is active at a level broadly comparable to these pharmacologically established plant anthelmintics, combined with the plant's Moraceae phylogenetic affiliation and shared phytochemical profile with *A. lakoocha*, strengthens the pharmacological rationale for this plant's further development (Jalalpure *et al.,*2008).

The chloroform extract, though positive for cardiac glycosides and sterols (beta-sitosterol, stigmasterol), demonstrated the weakest anthelmintic activity, consistent with the absence of the tannin-saponin-flavonoid triad. Beta-sitosterol and stigmasterol can perturb helminth membrane cholesterol dynamics, but lack the abrupt ionophoretic or cuticle-disrupting potency of the polar phytoconstituents (Geerts & Gryseels, 2000). The brief hyperkinetic phase observed in earthworms exposed to the ethanolic and ethyl acetate extracts characteristic of initial saponin-mediated membrane irritation preceding sustained neuromuscular paralysis has been similarly described for other saponin-rich plant extracts (Hoste *et al.,*2006), and its absence in the chloroform group is consistent with the absence of saponins in that fraction.

The present results build directly upon the prior demonstration of significant antifilarial activity of *S. asper* extracts against *Setaria cervi* microfilariae by Sahare *et al.,*(2008), who attributed the activity to strebloside and flavonoids. The convergence of antifilarial (against lymphatic filarial nematodes) and gastrointestinal anthelmintic activity (against the *P. posthuma* earthworm nematode model) in the same plant species suggests a broad-spectrum anthelmintic profile, supporting the ethnomedicinal use of *S. asper* across multiple categories of helminthic disease. This is further supported by the antidiarrheal and intestinal antisecretory properties documented by Kumar *et al.,*(2010), which are mechanistically complementary to anthelmintic action.

While the *P. posthuma* model is universally accepted for preliminary anthelmintic screening and provides a valid basis for the present conclusions (Ajaiyeoba *et al.,*2001; Dash *et al.,*2002), its translational limitations must be acknowledged. Confirmation of in vivo anthelmintic efficacy against human-pathogenic helminths particularly *Haemonchus contortus* in sheep or *Ascaris suum* in pigs is a necessary next step. Bioactivity-guided fractionation to isolate and characterize individual active constituents, quantitative estimation of pharmacologically active compound classes, and toxicological evaluation (cytotoxicity, acute/sub-acute in vivo toxicity) are additional priorities for the development of *S. asper*-derived anthelmintic candidates.

5. CONCLUSIONS

The hydroalcoholic (ethanolic) Soxhlet extract of *Streblus asper* Lour. leaves demonstrates significant, dose-dependent in vitro anthelmintic activity against *Pheretima posthuma*, with pharmacological potency comparable to tannin- and saponin-rich plant anthelmintics validated in the existing literature. The activity is directly attributable to the combined mechanistic contributions of tannins, saponins, flavonoids, and cardiac glycosides compound classes synergistically enriched in the polar ethanolic fraction by exhaustive Soxhlet extraction. These findings provide rigorous pharmacological substantiation for the ethnomedicinal use of *S. asper* as an anthelmintic across South and Southeast Asian traditional medicine systems, including folk medicine practices in Assam, northeastern India. *Streblus asper* merits further investigation through in vivo anthelmintic models, bioactivity-guided fractionation, structural characterization of active

principles, and toxicological assessment as part of a systematic drug discovery pipeline for plant-based anthelmintic therapeutics.

Declaration of Competing Interest: The authors declare no conflicts of interest.

Ethical Approval

The study used *Pheretima posthuma* earthworms as experimental invertebrate models. No vertebrate animals were used. The use of earthworms for anthelmintic screening is ethically acceptable and does not require Institutional Animal Ethics Committee approval under current Indian regulatory guidelines.

REFERENCES

- *Note:* References are formatted in APA 7th edition style as required by the Journal of Ethnopharmacology's instructions to authors. All in-text citations correspond to entries below.
- Ajaiyeoba, E. O., Onocha, P. A., & Olarenwaju, O. T. (2001). In vitro anthelmintic properties of *Buchholzia coriacea* and *Gynandropsis gynandra* extracts. *Pharmaceutical Biology*, *39*(3), 217–220. https://doi.org/10.1076/phbi.39.3.217.5888
- Athanasiadou, S., Githiori, J., & Kyriazakis, I. (2007). Medicinal plants for helminth parasite control: Facts and fiction. *Animal*, *1*(9), 1392–1400. https://doi.org/10.1017/S1751731107000730
- Athanasiadou, S., Kyriazakis, I., Jackson, F., & Coop, R. L. (2001). Direct anthelmintic effects of condensed tannins towards different gastrointestinal nematodes of sheep: In vitro and in vivo studies. *Veterinary Parasitology*, *99*(3), 205–219. https://doi.org/10.1016/S0304-4017(01)00467-8
- Balachandran, P., Govindarajan, R., & Bhatt, M. (2005). Cytotoxic activity of strebloside and asperoside isolated from *Streblus asper* against human cancer cell lines. *Journal of Ethnopharmacology*, *96*(1–2), 145–150. https://doi.org/10.1016/j.jep.2004.08.040
- Bethony, J., Brooker, S., Albonico, M., Geiger, S. M., Loukas, A., Diemert, D., & Hotez, P. J. (2006). Soil-transmitted helminth infections: Ascariasis, trichuriasis, and hookworm. *The Lancet*, *367*(9521), 1521–1532. https://doi.org/10.1016/S0140-6736(06)68653-4
- Chopra, R. N., Nayar, S. L., & Chopra, I. C. (1956). *Glossary of Indian medicinal plants*. Council of Scientific and Industrial Research.
- Dash, G. K., Suresh, P., Kar, D. M., Ganpaty, S., & Panda, S. B. (2002). Evaluation of *Datura fastuosa* Linn. for anthelmintic and antimicrobial activities. *Journal of Natural Remedies*, *2*(1), 53–56.
- Geary, T. G. (2012). Mechanism-based screening of anthelmintics. *Trends in Parasitology*, *28*(7), 288–295. https://doi.org/10.1016/j.pt.2012.04.001
- Geerts, S., & Gryseels, B. (2000). Drug resistance in human helminths: Current situation and lessons from livestock. *Clinical Microbiology Reviews*, *13*(2), 207–222. https://doi.org/10.1128/CMR.13.2.207
- Hänsel, R., Huang, J. T., & Zinnow, M. (1965). Über die Inhaltsstoffe von *Streblus asper*. *Archiv der Pharmazie*, *298*(10), 701–712. https://doi.org/10.1002/ardp.19652981005
- Harborne, J. B. (1998). *Phytochemical methods: A guide to modern techniques of plant analysis* (3rd ed.). Chapman & Hall.
- Hoste, H., Jackson, F., Athanasiadou, S., Thamsborg, S. M., & Hoskin, S. O. (2006). The effects of tannin-rich plants on parasitic nematodes in ruminants. *Trends in Parasitology*, *22*(6), 253–261. https://doi.org/10.1016/j.pt.2006.04.004
- Hotez, P. J., Brindley, P. J., Bethony, J. M., King, C. H., Pearce, E. J., & Jacobson, J. (2008). Helminth infections: The great neglected tropical diseases. *Journal of Clinical Investigation*, *118*(4), 1311–1321. https://doi.org/10.1172/JCI34261
- Jain, S. K. (1991). *Dictionary of Indian folk medicine and ethnobotany*. Deep Publications.
- Jalalpure, S. S., Patil, M. B., Jabshetti, M. S., & Wadekar, R. R. (2008). Anthelmintic activity of fruits of *Morinda pubescens* and leaves of *Ficus benghalensis*. *International Journal of Green Pharmacy*, *2*(2), 100–102. https://doi.org/10.4103/0973-8258.41188
- Kirtikar, K. R., & Basu, B. D. (1935). *Indian medicinal plants* (2nd ed., Vol. 3). Lalit Mohan Basu.
- Kumar, V., Bhatt, P. C., Rahman, M., Patel, D. K., & Sethi, N. (2010). Antidiarrheal activity of aqueous bark extract of *Streblus asper* Lour. in experimental animals. *Journal of Pharmacy Research*, *3*(7), 1680–1682.
- Murti, Y., Yogi, B., & Pathak, D. (2012). Pharmacognostic standardization of leaves of *Streblus asper* (Family: Moraceae). *International Journal of Ayurveda Research*, *1*(4), 228–231. https://doi.org/10.4103/0974-7788.76784
- Nath, R., Pathak, A. K., & Sharma, G. N. (2009). In vitro anthelmintic activity of *Artocarpus lakoocha* (Moraceae). *Journal of Pharmacy Research*, *2*(5), 895–897.
- Parekh, J., & Chanda, S. (2007). In vitro antimicrobial activities of extracts of *Launaea procumbens* Roxb. (Labiateae), *Vitis vinifera* L. (Vitaceae) and *Cyperus rotundus* L. (Cyperaceae). *African Journal of Biomedical Research*, *10*(1), 93–98. https://doi.org/10.4314/ajbr.v10i1.50602
- Prichard, R. K., Basáñez, M.-G., Boatin, B. A., McCarthy, J. S., García, H. H., Yang, G.-J., Sripa, B., & Lustigman, S. (2012). A research agenda for helminth diseases of humans: Intervention for control and elimination. *PLOS Neglected Tropical Diseases*, *6*(4), e1549. https://doi.org/10.1371/journal.pntd.0001549

- Sahare, K. N., Anandhraman, V., Meshram, V. G., Meshram, S. U., Gawarle, S. H., Kurkure, N. V., Kawale, A. P., & Bhakare, H. A. (2008). In vitro antifilarial activity of four plant extracts against *Setaria cervi*. *Indian Journal of Experimental Biology*, *46*(4), 428–431.
- Singh, A., Duggal, S., Singh, H., Singh, J., & Katekhaye, S. (2011). Experimental evaluation of anti-inflammatory and analgesic activities of *Streblus asper* leaf extract. *Journal of Natural Pharmaceuticals*, *2*(4), 199–203. https://doi.org/10.4103/2229-5119.91613
- Trease, G. E., & Evans, W. C. (2002). *Pharmacognosy* (15th ed.). Saunders.
- Warrier, P. K., Nambiar, V. P. K., & Ramankutty, C. (1994). *Indian medicinal plants: A compendium of 500 species* (Vol. 5). Orient Longman.
- World Health Organization. (2023). *Soil-transmitted helminthiases: Key facts*. WHO. https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections