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PHYTOCHEMICAL AND ANTHELMINTIC PROFILING OF *SOLANUM SURATENSE*: A HERBAL ALTERNATIVE FOR WORM INFECTION

Khwaja Masroor Ahmad[1]*, Manjusha Wath[2]

[,1,2]*Department of Botany, Government Vidarbha Institute of Science and Humanities, Amravati*
*Email - kmahmad1960@gmail.com; manjusharwath@gmail.com

ABSTRACT

Helminth infections remain a major global health concern, affecting millions, particularly in tropical and developing regions. Conventional anthelmintic drugs are effective but often lead to resistance, side effects, and high treatment costs, necessitating alternative solutions. Medicinal plants have emerged as promising sources of bioactive compounds with anthelmintic potential, offering safer, cost-effective, and eco-friendly treatments. Various phytochemicals, including alkaloids, flavonoids, and tannins, have demonstrated significant efficacy against parasitic worms. Exploring plant-based anthelmintics could provide sustainable therapeutic options, addressing drug resistance while enhancing global healthcare. This paper aims to evaluate the anthelmintic potential of *Solanum suratense,* focusing on its bioactive constituents, mechanisms of action, and therapeutic efficacy. The results indicate that the aqueous extract of Solanum suratense exhibits significantly greater anthelmintic efficacy compared to its alcoholic extract and the standard drug, piperazine citrate, against *Pheretima posthuma* and *Haemonchus contortus*. By examining both traditional knowledge and contemporary research, this study seeks to provide a comprehensive understanding of its role as a natural anthelmintic agent..

Keywords: *Solanum suratense*, Anthelmintic potential, Helminth infections, Traditional medicine, Natural anthelmintic, Phytochemistry.

INTRODUCTION

Helminth infections, caused by parasitic worms, are preventable and treatable but remain a major public health issue, especially in developing countries. According to a 2023 WHO report, about 1.5 billion people, or 24% of the global population, are affected by soil-transmitted helminth infections (STHs), with the highest prevalence in sub-Saharan Africa, China, South America, and Asia (World Health Organization, 2023) (accessed January 10, 2025). In India, STH infections are widespread, with one-quarter of South Asia's population infected in 2015 (Lai et al., 2019). The study identified moderate to high prevalence (>20%) in northeastern, northern, and southern coastal regions. *Ascaris lumbricoides* (roundworm) was found to be the most common parasite in India, followed by whipworm (*Trichuris trichiura*) and hookworm (*Necator americanus* and *Ancylostoma duodenale*) (Salam & Azam, 2017; Gujjeti et al., 2014; Vijayagiri et al., 2012).

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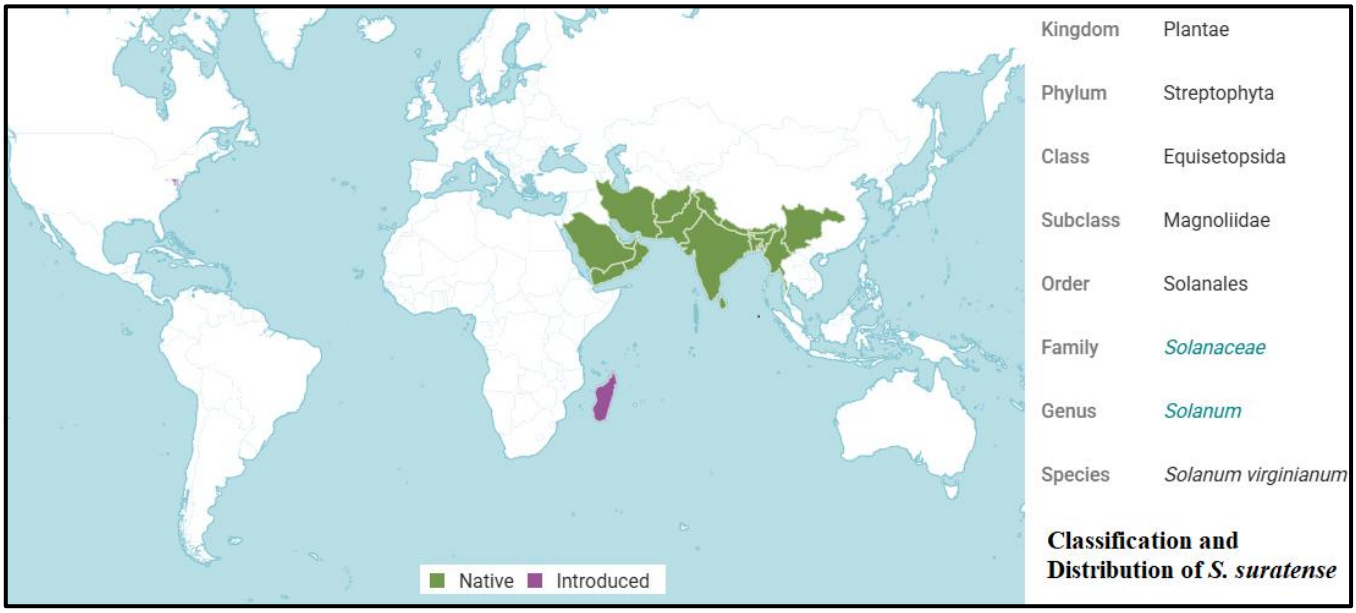

Figure 1: Classification and distribution of *Solanum suratense* (Royal Botanic Gardens, n.d.-c)

The Government of India has recognized soil-transmitted helminth (STH) infections as a major public health concern among children. The biannual National Deworming Day (NDD) was launched in 2015, and it administers WHO-approved Albendazole tablets through schools and 'anganwadis' to treat intestinal worm infections in children and adolescents (Press Information Bureau, 2020). But every year, some common temperory side effects like dizziness, nausea, vomiting, headache, mild fever has been reported.

In recent years, the excessive use of synthetic anthelmintic drugs has caused drug resistance and side effects, prompting the search for natural alternatives. *Solanum suratense* (*Solanum virginianum* L. syn. *S. surattense* Burm. f.) is a thorny medicinal plant with yellow berries from the Nightshade family *Solanaceae,* consisting of 102 accepted genera (Royal Botanic Gardens, n.d.-a). It is native to tropical Asia, including India and Sri Lanka, Arabian Peninsula, S. Iran to S. Central China and Myanmar (distribution and classification is shown in figure 1, source (Royal Botanic Gardens, n.d.-b)) and has been traditionally used in Ayurvedic and folk medicine for its anthelmintic, diuretic, and anti-inflammatory properties. Fruit is the most used part of the plant; followed by the whole plant together for the treatment of various ailments (Hasan et al., 2024; Gujjeti et al., 2013). Hasan et al. (2024) comments that this species holds ethnomedicinal significance, since it has been traditionally used for the treatment of skin diseases, piles-related complications, and toothaches.

The literature on *S. suratense* and its anthelmintic potential is scarce with very few studies exploring the potential of *S. suratense* as natural alternative to allopathic drugs against helminth infections. This study therefore, evaluated the alcoholic and aqueous extracts of *S. suratense* to analyse its anthelmintic properties.

MATERIALS AND METHODS

Experimental animals:

For the anthelmintic study Indian adult earthworms, *Pheretima posthuma* were collected from local wet soil and washed with normal saline to remove all of the fecal material. *Haemonchus contortus* used as animal model and collected from gastrointestinal tract of freshly slaughtered sheep from local slaughterhouses of Amravati (Maharashtra). The earthworms of 3-5 cm in length and 0.1-0.2 cm in width were used for all the experimental protocol.

Plant sample collection and preparation of extracts

In early 2022, fresh, live plant samples of *Solanum surattense* (syn. *Solanum virginianum* L., *S. surattense* Burm. f.) were collected from open areas around Amravati city, Maharashtra, India. Additional

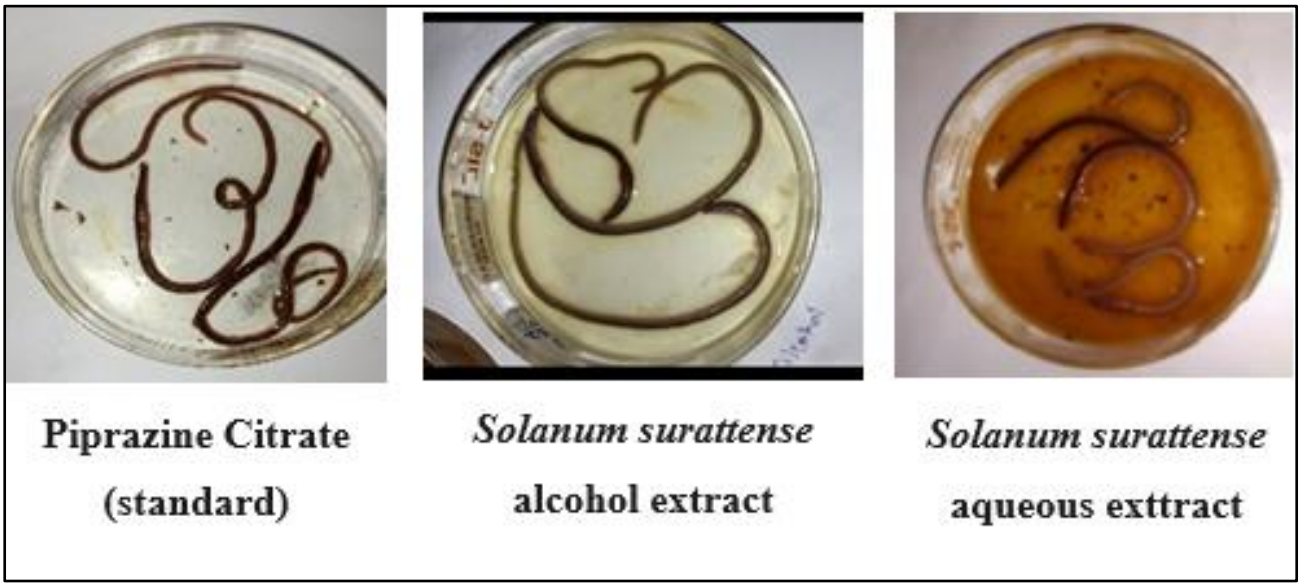

Figure 2. Anthelmintic assays for Solanum surattense

samples were gathered from the forests of the nearby Melghat Tiger Reserve in Chikhaldara, Amravati district. After identification of plants, herbarium specimens were prepared and authenticated by Department of Botany, Dr. Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhaji Nagar (Aurangabad), Maharashtra. (Accession no.: 00916 vide certification letter dated 30/11/2023).

Plant material was meticulously cleaned to remove any soil or dirt, and the dried seeds were finely powdered using an electric mixer. The powder was prepared. The dried seed about 10 gm was exhaustively extracted by hot continue extraction using Soxhlet apparatus 500 ml ethanol & extraction was performed for the varying period (2, 5, 8, 10 and 12 hrs) & aqueous extraction was performed by decoction method taking 10 gm at 40-45 °C for 2 hrs respective in 500 ml distilled water. The concentration mass was vacuum-dried to obtain constant weight.

Anthelmintic Assay

The anthelmintic activity was carried out as per the standard method of Deore et al., (2009) with minor modifications. *Pheretima posthuma* was selected as it has anatomical and physiological resemblance with the intestinal roundworm parasites of human beings. In this experiment, four groups of helminth worms (*Pheretima posthuma* and *Haemonchus contortus*) were released in 50 ml of solutions of piperazine citrate, aqueous and alcoholic extracts of plants (50 mg/ml each) in distilled water. Piperazine citrate was used as reference standard while distilled water as control. Observations were made based on the time taken to immobilize or destroy individual worms. Time for paralysis (PT) was noted when no movement of any sort could be observed except when the worms were shaken vigorously. Death (DT) was concluded with the loss of their motility from the worm followed by the fading of body color. Same experiment was done for *Haemonchus contortus* worms only the difference was solutions were prepared in normal saline solutions. The assays are shown in figure 2.

Phytochemical tests conducted

Qualitative phytochemical analysis was carried out using standard prescribed procedures to identify the following phytochemical constituents – Alkaloids, Anthraquinone, Phenol, Steroids, Tannin, Saponin, Flavonoids (Harborne, 1988; Thimmaiah, 1999).

RESULTS

The anthelmintic assay was administered to *Haemonchus contortus* and adult Indian earthworms *Pheretima posthuma* since it is easily available and bears anatomical and physiological resemblance to the intestinal roundworm parasite *Ascaris lumbricoides* found in human beings for the initial investigation of anthelmintic compounds in-vitro (Dash et al., 2002; Sollmann, 1918). Aqueous and alcoholic extracts of the plant *Solanum surattense* at

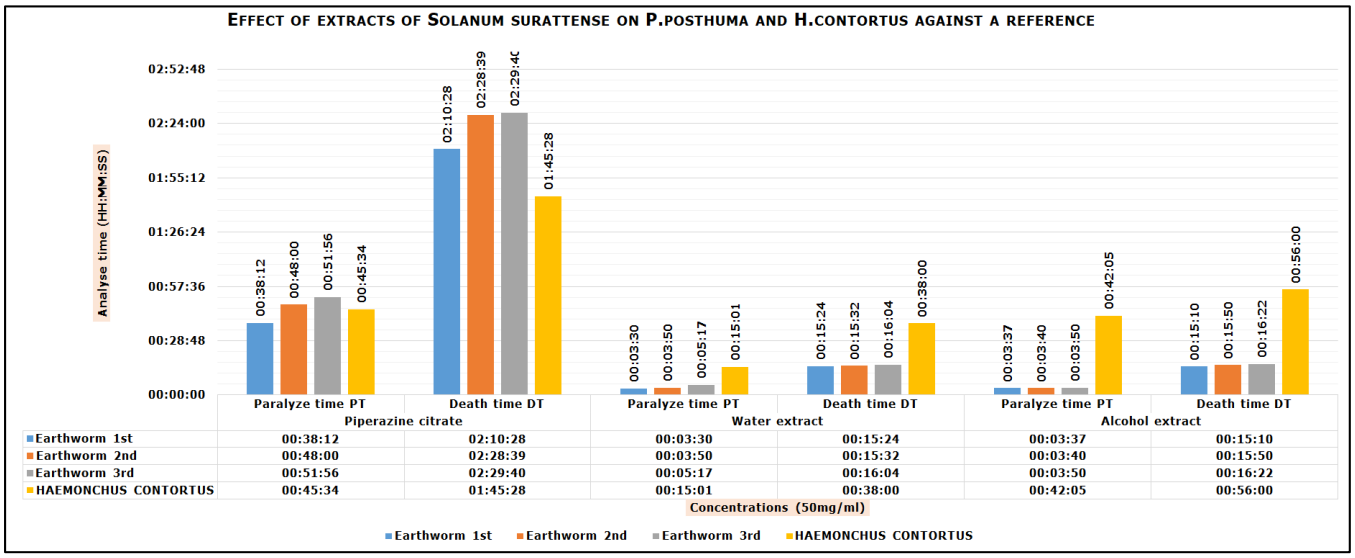

Figure 3. Effect of extracts of *Solanum surattense* on *Pheretima posthuma* and *Haemonchus contortus* compared to a standard reference drug (*Piperezine citrate*)

50mg/ml concentration each were used to evaluate the anthelmintic activity against a standard reference of Piperazine citrate and the result is shown as in figure 3.

The results of anthelmintic activity of the extracts of *Solanum surattense* reveal the following results:

(1) Paralysis time (PT) for standard Piperazine citrate was about 38 to 52 minutes with an average of 45 minutes for *P. posthuma* while PT for *Haemonchus contortus* was about 45 minutes. Paralysis Time (PT) for earthworm was noted to be between 3 to 5 minutes and for *H. contortus*, it was about 15 minutes for aqueous extract of *Solanum surattense* at 50 mg/ml concentration. For alchohol extract, PT was noted to be between 3 to 4 minutes for earthworm; while for *H. contortus*, it was about 42 minutes.

(2) Death time (DT) for piperezine citrate (PC)was noted to be between 130 minutes to 150 minutes for earthworm while for *H. contortus,* it was about 105 minutes. For aqueous extract, DT for earthworm was about 15 to 16 minutes, and about 38 minutes for *H. contortus*. For alchoholic extract, DT for earthworm was almost same at about 15 to 16 minuts but DT for *H. contortus* was noted to be about 56 minutes.

(3) From the results it is observed that, both water and alchohol extracts of *Solanum surattense* have elevated anthelmintic properties against the standard piperezine citrate (PC). The aqueous and alcohol extracts paralyses the earthworms about 92.1% faster than piperezine citrate (PC) while aqueous extract paralyzes *H. contortus* in just one-third of the time taken by piperezine citrate. The performance of alcoholic extract is almost the same as that of piperezine citrate for paralyzing *H. contortus*.

(4) Both the aqueous and alcoholic extracts are far superior to piperezine citrate in killing the helminths. Both the aqueous and alcoholic extracts kill the earthworms in almost the same time but aqueous extract is about 32.1% faster than alcoholic extract in killing *H. contortus* and is about 62% faster than piperezine citrate in killing *H. contortus.*

The results showed that the aqueous and alcoholic extracts possess varying degree of anthelmintic activity; i.e. extracts exhibited not only paralysis but also death of worms for both extract. From the above study, it was observed that the aqueous and alcoholic extract of *Solanum surattense* seeds were more potent anthelmintic, when compared to the standard drug piperezine citrate in a predetermined dose (50 mg/ml). The highest activity (shortest time for paralysis and death of worms) of the plant extract was found at the concentration of 50 mg/ml for

Table 1: Preliminary Phytochemical screening for *Solanum surattense*

NAME OF PHYTOCHEMICAL TEST	*SOLANUM SURATTENSE*	
	Water Extract W	Alcohol Extract A
CARBOHYDRATES		
Molisch's Test	+	-
Fehling's Test	+	+
Benedict's Test	+	+
Barfoed's Test	-	-
PROTEINS		
Biuret test	-	-
Millon's test	+	+
AMINO ACIDS		
Ninhydrin test	-	-
ALKALOIDS		
Dragendroff's reagent	-	+
Modified Dragendroff's reagent	-	+
Hager's reagent	-	+
Mayer's reagent	-	+
Wagner's reagent	-	+
GLYCOSIDES		
General Test	+	+
CARDIAC GLYCOSIDES		
Baljet reagent	-	-
Keller-killani test (digitoxose):	-	-
Legal test (Cardenolides)	-	-
OILS		
Filter paper test	-	-
Solubility test	-	-
Sudan red III test	NA	NA
Tincture alkana test	NA	NA
GUM MUCILAGE		
Ruthenium red test	-	-
FLAVONOIDS		
Shinoda test	+	+
Lead acetate	+	+
Alkali test	+	+
TANNINS		
Ferric chloride (5%)	+	+
Lead acetate test	+	+
Bromine water	NA	NA
STEROIDS / TRITEPENOIDS		
Liebermann test	NA	NA
Liebermann–Burchard test	NA	NA
Salkowski reaction	-	+
SAPONINS		
Foam test	+	-
Hemolytic test	NA	NA
ANTHRAQUINONES		
Borntrager's test	-	-
Schonteten's test for anthranols	NA	NA

...Table 2

NAME OF PHYTOCHEMICAL TEST	*SOLANUM SURATTENSE*	
Modified Borntrager's test	-	+-
CYANOGENETIC GLYCOSIDES	**NA**	**NA**
Sodium Picrate /Guignard test		
Mercurous nitrate test		
Guaiacum test		
COUMARIN GLYCOSIDES		
Odour test	-	-
Alkali test	-	-
Fluorescence test		
GUM MUCILAGE		
Swelling test	-	-

aqueous extract as compared to the alcoholic extract and standard drug.

The Earthworm and Haemonchus selected for anthelmintic activity was more sensitive to aqueous extract of *Solanum surattense*. It is observed that aqueous and alcoholic extract showed same anthelmintic potential for earthworms but for *H. contortus*, aqueous extract produced paralytic effect much earlier and the time taken for death is shorter than alcoholic extract. Thus, the results show more promising activity for aqueous extract of *Solanum surattense*.

The preliminary phytochemical analysis indicates the presence of Flavonoids, Phenols, Saponins, Steroids, Alkaloids, and Tannins in the plant. Phenolic compounds interact with cell surface glycoproteins, contributing to its anthelmintic effect. Alkaloids act on the central nervous system of the worm leading to its paralysis while Tannins bind to free proteins in the gastrointestinal tract and the parasite's cuticle, leading to the death of the helminth (Borba et al., 2010; Jitendra Patel et al., 2010). Presence of these phytochemical compounds significantly places *Solanum surattense* as a great herbal alternative to conventional drugs. Responses to various tests are shown in table 1.

DISCUSSION

Anthelmintic potential of *Solanum surattense* fruit extracts against adult Indian earthworms (*Pheretima posthuma*) was earlier reported with different kind of results (Nayak et al., 2009) in which evaluation of the both aqueous and ethanolic extracts demonstrated greater activity than standard drugs like Piperazine citrate and Albendazole across all tested doses. A detailed review work by (Tekuri et al., 2019) and (Pradeep Kumar, 2021) describes in details about the morphology, Phytochemical and pharmacological activities of *Solanum surattense*. The objective of another study was to check the potential of secondary metabolites of few selected plants, including *S. suratense* (Aldughaylibi et al., 2022). The results indicated that the plants, including *S. suratense*, are rich sources of natural products with antimicrobial, antioxidant, antidiabetic and anthelmintic potential, which make them promising for future drug discovery. Hasan et al. (2024) reports that a total of 338 metabolites of various chemical classes have been isolated from *S. surattense* in previous studies and experiments (Hasan et al., 2024).

Thus, these phytochemical constituents contribute to anthelmintic activity and their possible mechanism of action, leading to similar effects observed in the plant extracts. The present findings underscore the significant therapeutic potential of *Solanum virginianum* L. (syn. *S. surattense* Burm. F.), highlighting its bioactive compounds—alkaloids, flavonoids, and phenolic acids—which collectively enhance its medicinal / anthelmintic value.

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Conflicts of Interest

Authors declare that there is no conflict of interests regarding the publication of this paper.

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