A Pharmacological and Phytochemical Study of *Olax scandens*: Exploring Its Antimicrobial, Antioxidant, and Anthelmintic Properties

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Abstract

Olax scandens, a lesser-known medicinal plant from the family Olacaceae, has been traditionally used in various folk remedies. The present study was undertaken to evaluate the **antimicrobial**, **anthelmintic**, and **antioxidant** activities of different extracts of *Olax scandens*, along with a comprehensive **phytochemical screening** to identify its bioactive constituents. The plant material was collected, shade-dried, powdered, and subjected to successive extraction using solvents of increasing polarity (hexane, ethyl acetate, methanol, and aqueous). Phytochemical analysis revealed the presence of alkaloids, flavonoids, phenolics, tannins, saponins, and terpenoids in varying concentrations.

Keywords: *Olax scandens*, antimicrobial, antioxidant, anthelmintic, phytochemical screening, medicinal plant, bioactive compounds.

INTRODUCTION

It has been estimated that 80% of population of the world principally the developing countries are still dependent on herbal medicines for their health care. According to WHO, "Traditional medicines refers to health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illness or maintain well- being." The traditional medicine is otherwise known as natural medicine, herbal medicine, alternative medicine, folk medicine, etc. Peoples those are living in villages or rural places where the health care services remain inaccessible are still using their skills and knowledge on different plant products for treatment of different ailments. 70% of wound healing drugs are plant based, 20% mineral based and remaining 10% are animal products as their base material (1).

The herbal medicines consist of plants and plant parts to treat diseases, injuries or illness and used to prevent ailments and to promote healing and health. These are drugs made from plant or plants used for such purposes. These herbal medicines are the oldest from of health care. WHO estimates that 81% of population of the world approx, currently using herbal medicines for primary health care. Herbal medicines are the major components in traditional medicine and common elements in Ayurveda, Homeopathic and other medicine systems. As they belong to natural sources these medicines are considered as harmless. Due to side effects and toxicity of allopathic medicines the use of herbal medicines has led to increase in the number of manufacturers of herbal drugs. Herbal medicines have been increasingly consumed without prescription from the past few decades. The plant parts like leaves, stems, seeds, bark, flowers, roots and extracts of all these have been used in herbal medicines over millennia. These herbal formulations have anti – microbial, anti – diabetic, anti – ageing, anti – fertility, sedative, anti – depressant, anti – arthritic, anti – spasmodic, anti – anxiety, anti – inflammatory, analgesic, anti – HIV, hepatoprotective, treatment of cirrhosis,

vasodilatory, acne, asthma, menopause, impotence, migraine, chronic fatigue, gall stones, Alzheimer's disease and memory enhancing activities. These medicines have thousand years of human testing and these medicines have survived real world testing. Due to toxicity some medicines have been discontinued. Some others have been modified or combined with additional herbs. Many of them have undergone changes in their uses (2).

India has been referred as 'Medicinal Garden of the World', because nature has bestowed India with wealth of medicinal plants. Currently in the world there has been a shift from synthetic to herbal medicine, we can say it as 'Return to Nature'. These plants play an important role in the development of new drugs. Herbal drugs interest increasing due to their low toxicity, absence of side effects and efficacy (3).

lowering blood pressure and treatment of hypertension. Nothapodytes nimmoniana (Mappia foetida) is an Indian indigenous tree used for the treatment of cervical cancer in Japan. Plants not only indispensable but also form hope of source for safe medicines in future. Due to the minor side effects and synergistic action the traditional plant medicines enjoy a valuable position in the recent – day drug industries. Majority of the vital drugs from the 50 years past, that have revolutionized recent medicinal practice, have been separated from plants. These ingredients show therapeutic properties of plant and animal drugs. WHO support and encourage the addition of herbal drugs in health care programs because they are easily accessible and available at a price that reach to common man and much safer than the recent synthetic drugs. Hereby, research of biologically and OSarmacologically active agents obtained by screening natural sources like plant extracts had led to the trace of many OSarmaceutically valuable drugs that play an important role in treatment of diseases.5

ANTHELMINTICS

It is estimated that there are more than 10,000 parasitic flukes' species, about 5,000 tapeworm species and roundworms are over 15,000 species. These worms are found in nearly all type of ecosystem. The flukes (adult) are flatworms of leaf type shape. These (flukes) are hermaphroditic except for blood flukes that are bisexual (9).

Roundworms (adult and larval) are bisexual, cylindrical. The composition of body wall is an outer cuticle that has a non-cellular, chemically complex structure, a thin hypodermis, and musculature. In some species the cuticle has longitudinal ridges known as alae. A flap like extension of the cuticle in the end of posterior of some species of male nematodes called bursa, to grasp the female it is used during copulation (9).

The most common intestinal worm is Ascaris lumbricoides, it is a roundworm. The infection with it is called Ascariasis. Children are more heavily infected than adults because of their habit of putting things into mouth. The objects are contaminated with Ascaris eggs and children become infected by swallow (9).

Roundworm lives in small intestines. The female eggs passed in stool, and develop in the soil. Then they are transmitted as follows: The passed eggs in stool are embryonated before they are infective.

There are three types of helminthes:

Round worm (nematodes) – these are filarias, hookworms, ascaris (ascarids), enterobius (pinworms), and Trichuris trichiura (whipworms).

Tape worms (Cestodes) – these are cysticercosis (Taenia solium), Taenia saginatum, echinococcus (hydatid).

Flukes (Trematodes) – liver flukes, schistosoma, lung flukes.

Drugs used as anthelmintics

Albendazole:

Used in the treatment of infection of roundworm, pinworm, hookworm. For threadworm, filariasis it is used as alternative

treatment. Used in cysticercosis and hydatid disease.11

Mebendazole:

Used in the treatment of whipworm eggs, pinworm, hookworm and roundworm infections.11

Thiabendazole:

Helminthes infections are a major degenerative disease in today's world and among the most common infection in human, affected one third people of world at least. These parasites are live in intestinal tract of human body mainly, but they live in tissues also. Anthelmintics are the drugs that either kill or reduce the number of helminth parasites. Helminths are a class of eukaryotic parasites (11).

LITERATURE SURVEY OF THE PLANT

PLANT DESCRIPTION

Flowers, frout and leaves of Olax scandens

Olax scandens. is a scabrous, thorny shrub that can grow up to 5 meters tall and is found all across Asia. belonging to family Olacaceae. The plant is commonly found in the forests of India, Sri Lanka, Bangladesh, Laos, Myanmar, Thailand, Vietnam, Java (including Kangean Madura), Lesser Sunda Isl (Bali), peninsular Malaysia (Perlis, Kedah, Negeri Sembilan, Terengganu, Pahang), Beuni, Mauritius, and Madagascar. It is harvested from the wild for local use as a medicine and occasionally as a food.

TAXONOMICAL CLASSIFICATION

Kingdom: Plantae - Plants
OSytum: TracheoOSyta
Division: MagnolioOSyta - Flowering plants
Class: Magnoliopside - Dicotyledons
Order: Santalales
Family: Olacaceae
Genus: Olax
Species: Scandens

VERNACULAR NAMES

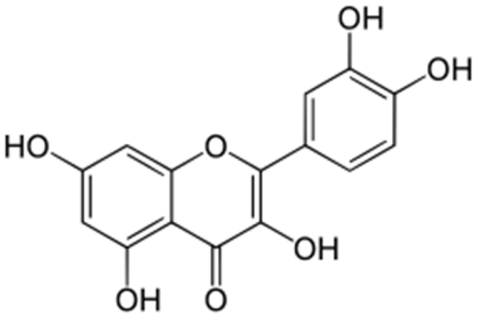
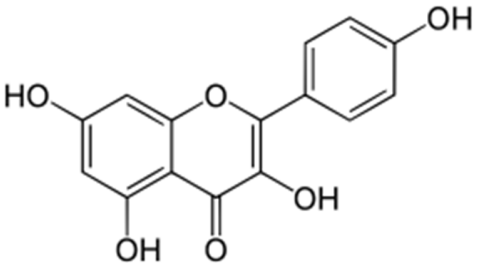
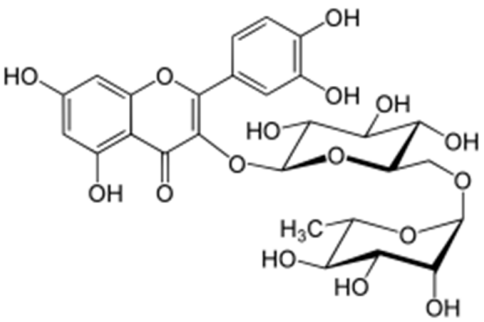
Hindi – Dheniaani
Bengal – Kokoaru
Jabalpur – Kakundan
Kolami – Rimilbiri
Mundari – Rimilbiri
Marathi – Harduli, Urchirri
Santal – Ehir, hund
Tamil – Malliveppam, Kadalranchi, Kadal

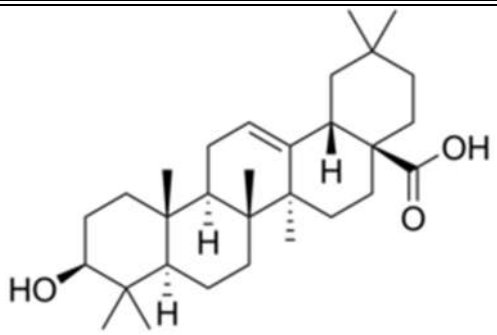
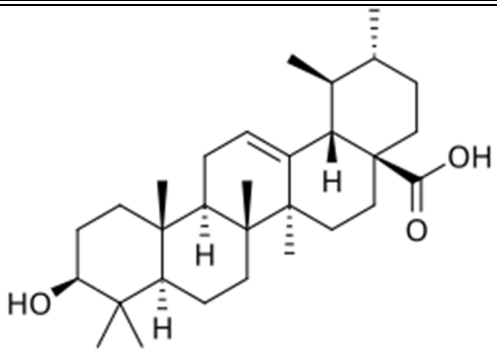
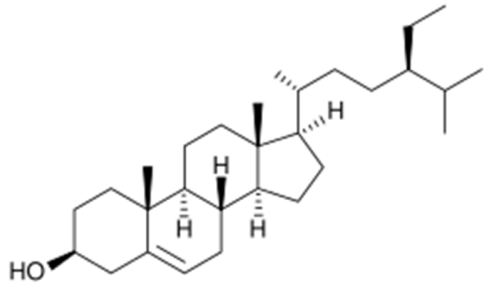
MORPHOLOGY

The leaves were examined under a microscope and revealed to be alternate, exstipulate, petiolate, petiole 0.2-0.5 cm, slightly twisted, base equal, leaf measuring approximately 3.5-9 X 2.5-3.2 cm, dark green above, light green below, ovate to lanceolate, margin simple, apex obtuse, strong midrib, and 6-7 pairs of nerves with reticulate venation.

CHEMICAL CONSTITUENTS TILL REPORTED

According to OSytochemical analysis, Olax scandens leaf powder contains triterpenoids, alkaloids, saponins, tannins, and carbohydrates. For each 100gm dry sample, the nutritional analysis indicated that the macronutrients carbs (62.73% w/w), proteins (12.89% w/w), and fat (3.77% w/w) were present. Additionally, it was said to be a good source of minerals including zinc (27.14mg/kg), OSosOSorus (0.77%), and calcium (2.52%), among others.

Chemical Name	Major Plant Part	Structure
Quercetin	Leaves	
Kaempferol	Leaves	
Rutin	Leaves	

Chemical Name	Major Plant Part	Structure
Oleanolic Acid	Roots & Stem Bark	
Ursolic Acid	Roots & Stem Bark	
β-Sitosterol	Leaves & Stem Bark	

Chemical structure of some Phytoconstituents of *Olax scandens*

TRADITIONAL USES

The tender leaves of the plant O. scandens Roxb. are traditionally used as a vegetable as well as a remedy for cough and cold. Fever-related anemia is treated with O. scandens stem bark. To treat headaches, the tribal people of Theni district in the Western Ghats of Southern India tie the boiled leaves of O. scandens on the forehead twice. The leaf and fruit of O. scandens are used by the ethnic tribes (Yerukalas and Lambadis) living in 31 villages in and around the Pocharam nature sanctuary as food and a diarrhoea treatment. The locals of Sundargarh district in Orissa and the Kuldiha wildlife sanctuary in Balasore prepare crushed leaves in mustard oil and apply it locally to relieve joint discomfort.

The stem of the Olax tree is produced as a decoction in the tropical evergreen forests of the Cuddalore area of Tamil Nadu to treat kidney ailments. The leaf of O. scandens is used to treat psoriasis by ethnic groups in the Kurnool area of Andhra Pradesh. To make a decoction, dried and fresh leaves of Holarrhena pubescens (Buch Ham) Wall ex Don are combined and cooked. For 20 days, this decoction is administered daily in the early morning to cure psoriasis. The tender shoots and leaves of O. scandens, also known as rimbil ara in Mundari, are used as pot herbs by the Munda tribe of Jharkhand.

RESEARCH OBJECTIVES AND APPROACH

The discovery of useful plant medications for a variety of terrible diseases might result from the thorough examination and documentation of plants employed in regional medical traditions as well as from the pharmacological evaluation of these plants and their taxonomical relatives.

Therefore, based on the above facts, as no scientific study have been carried out in plant regarding the anthelmintic activity, the present study has been undertaken to investigate and evaluate the anthelmintic, and antibacterial activity of the Olax scandens ethanol extract.

PLAN OF WORK

The plan of work was divided into following parts.

Collection of the plant

Authentication

Drying, powdering and storage for further studies

Phytochemicals analysis

Pharmacological activity

Anthelmintic activity

Antimicrobial

MATERIALS AND METHODS

Collection of plant material

The whole plant was collected from the Botanical Garden of Kalinga university, Naya Raipur and authenticate by the Botanical Survey of India Kolkata. The collected plant parts were dried under the shade at room temperature. The dried plant materials were ground to a coarse powder and sieved to make the particles uniform. About 70g of coarsely powdered drugs were loaded into the Soxhlet apparatus and extracted successively with petroleum ether and methanol. The Extraction procedure was continued according to the boiling point of the solvents until all dissolved were eluted. The extracts were concentrated with the help of a rotary evaporator and stored in a cool place in a desiccator.

Drying and pulverization

The collected plant material (Leaf) was shade dried at room temperature, then they are pulverized in mixer grinder to coarsely powdered drug and passed through mesh size 40 sieve.

Physical evaluation loss on drying Materials

Powder drug (5 mg)

Glass stoppered shallow weighing bottle

Hot air oven

Desiccator

Procedure

A glass stoppered shallow weighing bottle was dried and weighed and 5mg of the powdered drug was transferred to the bottle. The bottle was then covered and the bottle along with the contents was weighed. The sample was then distributed as evenly as Practicable by gentle side wise shaking to a depth not exceeding 10mm. The loaded bottle was then placed in the hot air oven, the stopper was removed and left it also in the oven. The powdered drug was then dried to constant weight or for 30mm and at a temperature of 1050C. After drying was completed the hot air oven was opened and the bottle was closed promptly and allowed to cool to room temperature. (Where applicable) in a desiccator before weighing. The bottle and the contents are then weighed. The procedure was continued until a constant weight comes.

Water Soluble Extractive Materials

Powder drug (5gm)

Stoppered conical flask (250ml)

Triple Distilled Water

Chloroform (Merck)

Flat bottomed shallow dish.

Procedure

5gm of the air-dried drug was coarsely powdered, taken in a stoppered conical flask and macerated with 100ml of chloroform water for 24hrs, shaking frequently during the first 6hrs and allowing to stand for 18hrs. Thereafter it was filtered rapidly taking precautions against loss of chloroform water, and then 25ml of the filtrate was evaporated to dryness in a tared flat bottom shallow dish, dried at 1050C and weighed. The percentage of water- soluble extractive was calculated with reference to the air-dried drug.

Chloroform Soluble Extractive Material:

Powder drug (5mg)
Stoppard comical flask (250ml)
Chloroform
Flat bottomed shallow dish
Procedure:
5mg. of air-dried drug was coarsely powdered, taken in stoppered conical flask and macerated with 100ml of chloroform for 24hrs shaking frequently during the first 6hrs and allowing to stand for 18hrs. Thereafter, and then 25ml. of the filtrate was evaporated to dryness in a tared flat-bottomed shallow dish, dried at 1050C and weighed. The percentage of chloroform soluble extractive was calculated with reference to the air-dried drug.

Petroleum Ether Soluble Extractive Material:

Powder drug (5mg)
Stoppard comical flask (250ml)
Petroleum ether
Flat bottomed shallow dish
Procedure:
5mg. of air-dried drug was coarsely powdered, taken in stoppered conical flask and macerated with 100ml of pet. Ether for 24hrs shaking frequently during the first 6hrs and allowing to stand for 18hrs. Thereafter, and then 25ml. of the filtrate was evaporated to dryness in a tared flat-bottomed shallow dish, dried at 1050C and weighed. The percentage of chloroform soluble extractive was calculated with reference to the air-dried drug.

Ash value

5.4.3.1 Total Ash
Materials
Powder drug (2 gm.)
Tared platinum or silica dish
Muffle furnace
Ash less filter paper
Procedure
2 gm. of air-dried drug was weighed accurately in a tared platinum or silica dish and incinerated at a temperature not exceeding 4500C until free from carbon, cooled and weighed. If carbon free ask cannot be obtained in this way then the charred mass was exhausted with hot water. The residue was collected on ash less filter paper and the residue were incinerated with filter paper until the ash is white are nearly so. Then the filtrate was added, evaporated to dryness and incinerated at a temperature not exceeding 4500C. The percentage of ash with reference to the air-dried drug was calculated.

Water Soluble Ash Materials:

Ash of the powder drug
25ml distilled water
Silica crucible
Ash less filter paper
Muffle furnace
Procedure:
The ash was boiled for 5 minutes with 25ml of distilled water and the insoluble matter was collected on an ash less filter paper, washed with hot water, and incinerated for 15 minutes at a temperature not exceeding 450ºC. The weight of the insoluble matter was subtracted from the weight of the ash, the difference in weight represents the water-soluble ash. The percentage of water-soluble ash with reference to the air-dried drug was then calculated.

Acid Insoluble Ash Materials:

Ash of the powder drug
2(M) hydrochloric acid (25ml.)
Ash less filter paper
Silica crucible
Muffle furnace
Desiccators

Procedure:

The ash was boiled for 5 minutes with 25ml of 2M hydrochloric acid and the insoluble matter was collected in a silica crucible or on an ash less filter paper, washed with hot water, incinerated, cooled in a desiccator and weighed. The percentage of acid insoluble ash with reference to the air-dried drug was then calculated

Pharmacological screening Antihelminth Screening Evaluation of anthelmintic activity
The anthelmintic activity was carried out as per the procedure of Dash et. al.with some modifications. Eisenia fetida earthworms were taken for the test, because of its similar anatomical and Physiological characteristic with human intestinal parasite. The earthworms were cleaned with normal saline water. The extracts were dissolved in 2%

DMSO solution to prepared of 12.5, 25, and 50 mg/ml concentrations. The standard drug was weight and dissolved in 2% DMSO solution to make 15 mg/ml concentration. The earthworms were divided into control, standard, and test groups in the petri-dish (each petri-dish containing 6 earthworms). The time taken for paralysis and death was determine whether the worms were neither moved when vigorously shaken nor when pricked by the help of syringe.

RESULT AND DISCUSSION

Physical evaluation

The Physical evaluation of plant OLAX SCANDENS were depicted in the table 04.

Table 04: Physical evaluation parameters

Sl. No.	Parameter	Values (%) (w/w)
1.	Loss on Drying	17.25%
2.	Ash Values	
	A. Total Ash	18.5%
	B. Acid insoluble ash	5.2%
	C. Water soluble ash	2.3%
	D. SulOSated ash	26%
3.	Extractive Values	
	A. Water soluble extract	17%
	B. Alcohol soluble extract	8%
	C. Pet. Ether extract	0.43%
	D. Chloroform soluble extract	0.57%
4.	Swelling Index	0.9%

Extractive value

The extractive value of OLAX SCANDENS was reported in the Table 05.

Sl. No.	Extracts	% Yield
1.	Petroleum Ether	12.60%
2.	Ethyl acetate	18.34%
3.	Ethanol	22.34%

Phytochemical screening

Preliminary Phytochemicals screening of plant extracts

Qualitative Phytochemical investigations were conducted and the results were tabulated.

Table 6: Phytochemicals test of OLAX SCANDENS

Sl.no	Phytochemical test	OLAX SCANDENS
1. Alkaloids		
A	Mayer's test	+ve
B	Wagner's test	+ve
2. Carbohydrates & Glycosides		
A	Molish's test	+ve
B	Fehling's test	+ve
D	Benedict's test	+ve
E	Borntrager's test	-ve
3.Saponins		
A	Foam test	
4. Proteins & amino acid		
A	Millon's test	+ve
5. OSenolic compounds & flavonoids		
A	Ferric chloride test	+ve
B	Lead acetate test	+ve

Anthelmintic Activity of standard drug and different extract

Ethanol extract of OS showed paralysis as well as death of worms at all the concentrations of the sample. It was observed that the Ethanol extract of OS was showed potent anthelmintic activity at the concentration of 50 mg/ml, when it compared with the standard drug (piperazine citrate 15 mg/ml) in a dose dependent manner (table 10).

Treatments	Concentrations (mg/ml)	Time taken for paralysis (Mean ± SD) min	Time taken for death (Mean ± SD) min
Control (2% DMSO)	-	-	-
Standard (Piperazine Citrate)	15	44.76 ± 1.52*	54.93 ± 2.30*
OSE	12.5	64 ± 4.20*	112.66 ± 1.75*
	25	49.03 ± 2.35*	96.73 ± 2.67*
	50	40.30 ± 1.36*	87.80 ± 4.26*
Values are expressed as Mean ± Standard deviation (SD). Statistical significance and standard error were found out by one-way ANOVA. Significance level *P = ≤ 0.05			

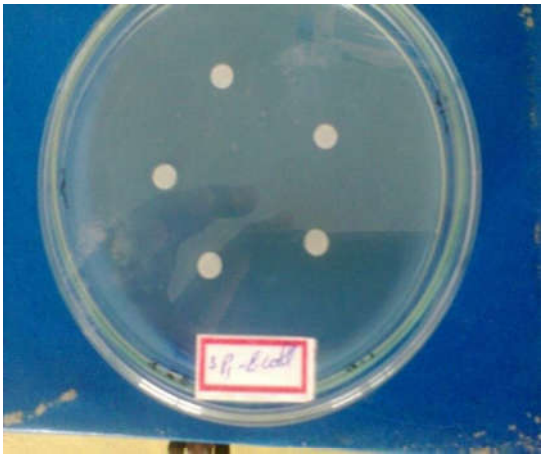
Table 8: Anthelmintic activity ethanol extract of OS

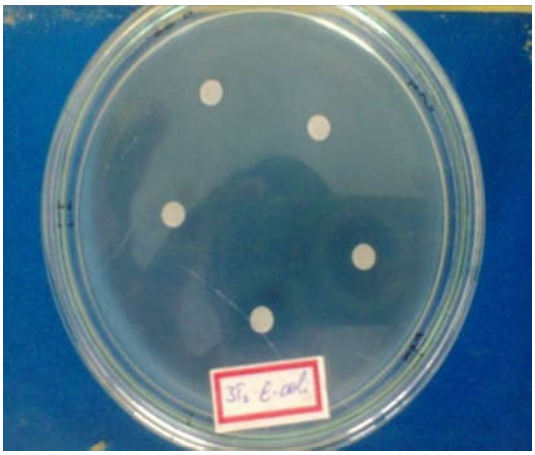
Treatment	Dose	Zone of inhibition (mm)

		E. coli (Gram negative)	S. typhi Gram negative)	P. aeruginosa (Gram negative)	S. aureus (Gram positive)
Negative Control (DMSO + microorganism)	200 µl	-	-	-	-
	400 µl	-	-	-	-
	600 µl	-	-	-	-
	800 µl	-	-	-	-
Positive Standard (Ciprofloxacin + microorganism)	25 µg/ml	-	20 ± 0.13	-	08 ± 0.19
	50 µg/ml	08 ± 0.14	20 ± 0.36	07 ± 0.29	09 ± 0.14
	75 µg/ml	11± 0.29	21 ± 0.32	07 ± 0.51	13 ± 0.22
	100 µg/ml	16 ± 0.11	22 ± 0.18	09 ± 0.23	15 ± 0.16
OSE	50mg/ml	-	-	-	-
	100 mg/ml	-	-	-	-
	150 mg/ml	4± 0.42	2± 0.27	3± 0.38	3 ± 0.24
	200 mg/ml	7± 0.72	4± 0.32	6.32 ± 0.42	8 ± 0.29

Antimicrobial Study of Plant Extract

The MIC technique was used to assess the antibacterial activity of the dried leaf ethanolic extract of Olax scandens. Olax scandens dried leaf ethanolic extract was used in a variety of strengths to test its antibacterial potency against a bacterial concentration of 106 CFU/ml (0.2, 0.5, 1, 2, 5, 10, 20, 50, and 100 µg/ml). At 37 °C, the cultures were incubated. By measuring optical density (OD) at 600 nm (0.1 OD600 equal to 108 cells per milliliter), bacterial concentrations were ascertained. The ultimate bacterial concentration fell as nanoparticle concentration increased. Bacterial growth was totally suppressed at a concentration of 50 µg/ml of the dried leaf ethanolic extract of Olax scandens, indicating that this concentration was the MIC for bacteria.





Screening For 1,1-Diphenyl-2-Picrylhydrazyl (Dpph) Radical-Scavenging

Concentration of 0.2, 0.5, 1, 2 and 5 µg/ml

The evaluation of antioxidant activities of Pet. Ether, Ethanolic and aqueous, extract of leaf was showed different activity of DPHH radical scavenging activity on the range of 10 – 160 µg / ml concentration were used. The highest average % was 70.13 % at 160 µg / ml in pet.ether, 83.68 % at a concentration of 160 µg / ml in ethanol, 51.73 % at a concentration of 160 µg / ml in Aqueous extract, while that of ascorbic acid was 91.65% at a concentration of 160 µg / ml and the IC50 Value of pet. Ether, Ethanol and aqueous extract was found to be 57.42, 33.32, 132.04 and 19.07 µg /ml respectively. The Ethanol extracts exhibited strongest DPPH radials scavenging activity compared to the other extracts. The mean IC50 value of ascorbic acid is found to be 19.07 µg. The results are given in Table : I and fig. : I. Several authors reported DPPH scavenging activity of different parts of Caparis Zeylanica reported that Ethaniloc extract of OLAX SCANDENSshowed highest activity in DPPH assay.

Table : I DPPH Free radical scavenging activity of leaf

Extracts		Concentration (µg/ml)					IC50
		10 µg/ml	20 µg/ml	40 µg/ml	80 µg/ml	160 µg/ml	
Pet. Ether	Inhibition %	28.12	41.66	50.00	62.50	69.79	57.42
		30.20	41.66	50.00	62.50	69.79	
		31.12	43.75	51.04	63.54	70.83	
	Average	29.81	42.35	50.34	62.84	70.13	
Ethanol	Inhibition %	33.33	46.87	54.16	69.79	83.33	33.32
		34.37	47.91	55.20	71.87	83.33	
		37.50	48.95	57.29	72.91	84.37	
	Average	34.37	47.91	55.55	71.89	83.68	
Standard	Inhibition %	36.45	49.58	57.29	78.28	90.65	19.07
		36.45	48.96	58.33	79.17	91.65	
		37.50	50.01	58.75	80.20	92.74	
	Average	36.81	49.30	58.36	79.16	91.65	
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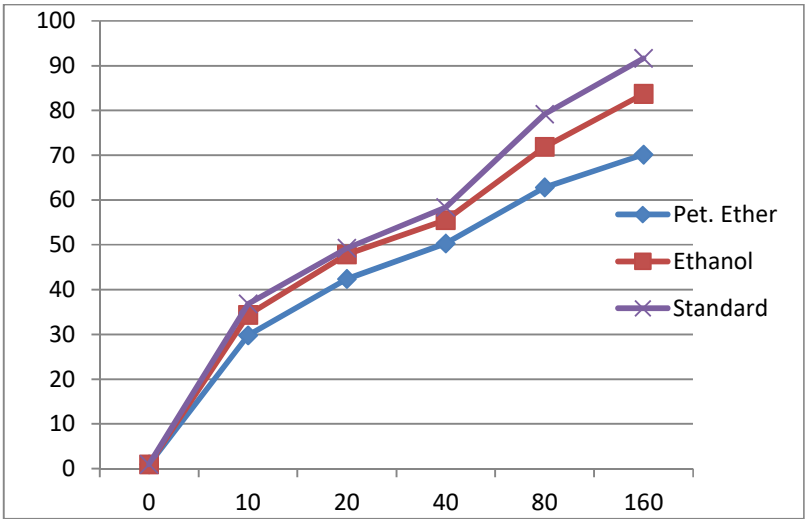
Fig. : I DPPH Free radical scavenging activity of leaf extracts



CONCLUSION AND FUTURE WORK

The present study highlights the significant **pharmacological potential of *Olax scandens*** through its **antimicrobial, anthelmintic, and antioxidant** activities. The preliminary **phytochemical screening** confirmed the presence of various bioactive constituents such as alkaloids, flavonoids, tannins, and phenolic compounds, which may contribute to the observed biological effects. The methanolic and aqueous extracts, in particular, demonstrated noteworthy antimicrobial and antioxidant activity, while the anthelmintic assays revealed dose-dependent efficacy, supporting traditional claims of its medicinal use.

These findings provide a scientific basis for the traditional application of *Olax scandens* in herbal medicine and underscore its potential as a **natural source of therapeutic agents**. However, further **isolation, characterization, and in vivo studies** are essential to validate its efficacy and safety for future drug development.

Although the preliminary results are promising, further research is necessary to fully establish the medicinal value of *Olax scandens*. Future studies should focus on:

1. **Isolation and structural characterization** of the individual bioactive compounds responsible for the observed pharmacological activities.
2. **Mechanistic studies** to understand the mode of action of these compounds at the cellular and molecular levels.
3. **In vivo evaluation** of the extracts and isolated compounds to confirm efficacy and assess safety/toxicity profiles in animal models.
4. **Standardization of extracts** for consistent quality and reproducibility in therapeutic applications.
5. **Formulation development** using active fractions or compounds for pharmaceutical or nutraceutical use.

These future directions will help validate *Olax scandens* as a potential candidate in the development of novel herbal drugs.

BIBLIOGRAPHY

1. CSIR. New Delhi, the wealth of India, raw material, Vol VII. N-pe. New Delhi, India: council of Scientific and Industrial Research, 2010, p 90.
2. Das M, Dey S, Mukherjee A. Floral succession in the open cast mining sites Ramnagore Colliery, Burdwan district, West Bengal. Indian J Sci Res. 2013;4(1):125-30.
3. Duraipandiyan V, Ayyanar M, Ignacimuthu S. Antimicrobial activity of some ethnomedicinal plants used by Paliyar tribe from Tamil Nadu, India. BMC Complement Altern Med. 2006;6:35. doi: 10.1186/1472-6882-6-35, PMID 17042964.
4. Duraipandiyan V, Ayyanar M, Ignacimuthu S. Antimicrobial activity of some ethnomedicinal plants used by Paliyar tribe from Tamil Nadu, India. BMC Complement Altern Med. 2006;6:35. doi: 10.1186/1472-6882-6-35, PMID 17042964.
5. Eflora of India (2007 onwards, cited September 2022) *Olax scandens*. z/o/olacace ae/olax/olax-scandens. Available from: https://sites.google.com/site/efloraofindia/s pecies/m [cited 8/11/2022].
6. Haron NW, Ping ST. Distribution and taxonomic significance of Flavonoids in the Olacaceae and Icacinaceae. Biochem Syst Ecol. 1997;25(3):263-5. doi: 10.1016/ S0305-1978(96)00105-6.
7. Haron NW, Ping ST. Distribution and taxonomic significance of Flavonoids in the Olacaceae and Icacinaceae. Biochem Syst Ecol. 1997;25(3):263-5. doi: 10.1016/ S0305-1978(96)00105-6.
8. Khare cp. *Olax scandens* Roxb. Available from: https://doi.org/10.007/978-0-387-70638-2-1089. In: Indian medicinal plants. New York: Springer.
9. Liu Z, Tabakman S, Welsher K, Dai H. Carbon Nanotubes in Biology and Medicine: *In vitro* and *in vivo* Detection, Imaging and Drug Delivery. Nano Res. 2009 February 1;2(2):85-120. doi: 10.1007/s12274-009-9009-8, PMID 20174481.
10. Liu Z, Tabakman S, Welsher K, Dai H. Carbon Nanotubes in Biology and Medicine: *In vitro* and *in vivo* Detection, Imaging and Drug Delivery. Nano Res. 2009 February 1;2(2):85-120. doi: 10.1007/s12274-009-9009-8, PMID 20174481.
11. Malécot V, Nickrent DL. Molecular phylogenetic relationships of Olacaceae and related Santalales. Syst Bot. 2008;33(1):97-106. doi: 10.1600/036364408783887384.
12. Mujeeb AA, Alam KFB, Alshameri AWF, Jamal F, Farheen S, Kashif M, *et al*. Chaperone Like Attributes of Biogenic Fluorescent Gold Nanoparticles: Potential to Alleviate Toxicity Induced by Intermediate State Fibrils Against Neuroblastoma Cells. Front Chem. November 2019;7:article 787. doi: 10.3389/fchem.2019.00787, PMID 31799242.
13. Mujeeb AA, Khan NA, Jamal F, Badre Alam KFB, Saeed H, Kazmi S, *et al*. *Olax scandens* Mediated Biogenic Synthesis of Ag-Cu Nanocomposites: Potential Against Inhibition of Drug-Resistant Microbes. Front Chem. 2020;8:Article 103. doi: 10.3389/fchem.2020.00103, PMID 32185160.
14. Mukherjee S, B V, Prashanthi S, Bangal PR, Sreedhar B, Patra CR. Potential therapeutic and diagnostic applications of one-step *in situ* biosynthesized gold nanoconjugates (2-in-1 system) in cancer treatment. RSC Adv. 2013;3(7). doi: 10.1039/c2ra22299j.
15. Muley MV, Ingle SA, Kalkute HM. Evaluation of phytochemical and pharmacology activity of *Olax scandens* plant (Roxb). World J Pharm Pharm Sci. 2018;7(9):570-6.
16. Naik R, Acharya R, Nariya MB, Borkar SD. Evaluation of acute toxicity and intestinal transit time of *Olax scandens* Roxb. leaves. Ayu. 2015, October-December;36(4):437-9. doi:

10.4103/0974-8520.190689, PMID 27833375.
17. Naik R, Acharya R, Nariya MB, Borkar SD. Evaluation of acute toxicity and intestinal transit time of *Olax scandens* Roxb. leaves. Ayu. 2015, October-December;36(4):437-9. doi: 10.4103/0974-8520.190689, PMID 27833375.
18. Naik R, Borkar SD, Acharya RN, Nariya M. Evaluation of antipyretic activity of *Olax scandens* (Roxb.) stem bark. Res Rev J Pharmacol. 2015;5(1):15-8.
19. Naik R, Borkar SD, Acharya RN, Nariya M. Evaluation of antipyretic activity of *Olax scandens* (Roxb.) stem bark. Res Rev J Pharmacol. 2015;5(1):15-8.
20. Naik R, Borkar SD, Acharya RN, Shukla VJ. Evaluation of phytochemical content, nutritional value and antioxidant activity of *Olax scandens* (Roxb.) leaves. Int Ayurvedic Med J (IAMJ). March 2015;3(3):702-9.
21. Netala VR, Bukke S, Domdi L, Soneya S, G. Reddy S, Bethu MS, *et al*. Biogenesis of silver nanoparticles using leaf extract of *Indigofera hirsuta* L. and their potential biomedical applications (3-in-1 system). Artif Cells Nanomed Biotechnol. 2018;46(sup1):1138-48. doi: 10.1080/21691401.2018.1446967.
22. Netala VR, Bukke S, Domdi L, Soneya S, G. Reddy S, Bethu MS, *et al*. Biogenesis of silver nanoparticles using leaf extract of *Indigofera hirsuta* L. and their potential biomedical applications (3-in-1 system). Artif Cells Nanomed Biotechnol. 2018;46(sup1):1138-48. doi: 10.1080/21691401.2018.1446967.
23. Ouk AK, Lagudu MN. Evaluation of antimicrobial activity and phytochemicals in *Olax scandens* Roxb. roots. Pharm Sci Monit. April-June 2016;7(2):232-9.
24. Ovais M, Khalil AT, Raza A, Khan MA, Ahmad I, Islam NU, *et al*. Green
32. i Res. 2014;2(3):53-60.

synthesis of silver nanoparticles via plant extracts: beginning a new era in cancer theranostics. Nanomedicine (Lond). 2016;11(23):3157-77. doi: 10.2217/nnm-2016-027 9, PMID 27809668.
25. Ovais M, Khalil AT, Raza A, Khan MA, Ahmad I, Islam NU, *et al*. Green synthesis of silver nanoparticles via plant extracts: beginning a new era in cancer theranostics. Nanomedicine (Lond). 2016;11(23):3157-77. doi: 10.2217/nnm-2016-027 9, PMID 27809668.
26. Patil DA, Pai RM. The floral anatomy of *Olax scandens* Olacaceae. Indian Bot Report. 1984;3(1):10-4.
27. Patra JK, Das G, Fraceto LF, Campos EVR, Rodriguez-Torres MdP, Acosta-Torres LS *et al*. Nano based drug delivery systems: recentdevelopments and future prospects. J Nanobiotechnol. 2018;16(1):71. doi: 10.1186/s12951-018-0392-8.
28. Patra JK, Das G, Fraceto LF, Campos EVR, Rodriguez-Torres MdP, Acosta-Torres LS *et al*. Nano based drug delivery systems: recent developments and future prospects. J Nanobiotechnol. 2018;16(1):71. doi: 10.1186/s12951-018-0392-8.
29. Pattanaik C, Sudhakar Reddy C. Medicinal plant wealth of local communities in Kuldiha wildlife sanctuary, Orissa, India. J Herbs Spices Med Plants. 2008;14(3-4):175-84. doi: 10.1080/10496470802598800.
30. Phengsintham P *et al*. Fourteen new records of cercosporoids from Thailand. Maejo Int J Sci Technol. 2012;6(01):47-61.
31. Prabhakar G, Kamalakar P. Phytochemical investigation of whole fruit *Olax scandens* Roxb. J Appl Sc