



Review Article

EXPLORING THE LITERATURE ON *PROSOPIS CINERARIA* LINN. FOR ITS THERAPEUTIC POTENTIAL AND SAFETY: A REVIEW

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ABSTRACT

Prosopis cineraria (L.) Druce. (Family Leguminosae, subfamily Mimosoideae), is locally known as Ghaf. The plant effects socially, ethnologically, traditionally and remedially in the life of the people. The proposition is to summarize the current studies on up-to-date and comprehensive information, highlighting bioactive potential of the plant. The review aimed to revise the information available regarding the therapeutic activities published in scientific journals and to provide a comprehensive tabulated data in such a way that it is useful for academic researcher. This paper includes a synthesis of information, the use of indigenous, traditional and scientific knowledge accumulated in the past years leading to therapeutic potential of the plant. A through scientific search of *P. cineraria* (L.) was carried out on phytochemical constituents viz. leaf, stem, pod, bark, and their pharmacological data and safety. The review is helpful in utilizing abridged scientific knowledge of the *P. cineraria* (L.), identifying gaps in, and future possibilities to work with.

Keywords: Ghaf; *Prosopis cineraria* (L.); Traditional usage; Therapeutic potential

INTRODUCTION

THE PLANT *Prosopis cineraria* (L.) DRUCE

The *Prosopis cineraria* (L.) Druce occurs in most of the world's hot arid and semi-arid regions as native or introduced species¹. The Great Indian Desert, popularly known as the Thar, the arid regions is characterized by the extremely arid climate with low and erratic rainfall, dry atmosphere and high wind velocities. *P. cineraria* (L.)². Its population is centered on the of India and Pakistan, but smaller populations occur in Iran, Afghanistan, and the Arabian Peninsula³⁻⁶. *P. cineraria* (L.) is an important native species to the Northeastern United Arab Emirates (UAE), locally known as Ghaf and is among few trees growing in the arid deserts of the UAE and constitute a major ecological feature and is beneficial for the growth and development of other species^{7,8}. The climate of the UAE is characterized by high temperatures, high humidity, and low rainfall⁹. Bedouin traditional lifestyle in UAE has been very much associated with the *Prosopis* trees and their products¹⁰. The rapid growth and modernization of infrastructure have led to noticeable changes in the Emirati way of life. As the country rapidly modernizing and due to rapid change in socioeconomic conditions of the country, the dependency of Bedouins become less and less on the plant. Less number of people get benefit by the plant as was practiced earlier. Therefore, the plant has been badly neglected for scientific studies. The negligence is reflected from the fact that almost no scientific work has been carried out on the plants especially from the medicinal and nutritional potential point of view. Whatever responsiveness is shown is from agroforestry related studies^{11,12}. Moreover, the *Prosopis* sp. is considered as

the national symbol of UAE¹³, a key focus in the UAE according to the future vision 2021 plan¹⁴.

Literature search showed that much of the work related to the exploration of medicinal properties of the plant has been carried out in Indian and Afghanistan desert conditions¹⁵⁻²². The plant is yet to be explored in other environmental conditions for its therapeutic/medicinal properties²³. In our laboratory, investigation has been undertaken to evaluate pharmacological and safety studies, financed by Ajman University, to confirm the allied traditional uses of the plant and its therapeutic potential.

For the present review, the information about *P. cineraria* (L.) search was carried out by Google, Google Scholar, PubMed and new generation research tool SciFinder was used for literature search of the plant.

SPECIES

The genus *Prosopis* as described by Burkart²⁴ consists of 44 species. They have been introduced globally and have become invasive in many places⁷, as native or introduced species²⁵.

DISTRIBUTION

P. cineraria (L.) mainly distributed in the deserts of India, Pakistan, Afghanistan, Iran, and the Arabian Peninsula²⁶. In the Arabian Peninsula, *P. cineraria* (L.) exists mostly in the UAE and Oman²⁷, *Prosopis* has been reported to occur in 129 countries globally and many more countries are climatically suitable²⁸.

TRADITIONAL USES OF THE PLANT

Prosopis sp. is known as “Golden tree”, has been used for a variety of traditional uses for more than 5000 years in their native ranges¹. The tree is worshiped customarily²⁹ and nearly all the parts of the plants are used traditionally by indigenous people for curing various ailments³⁰⁻³². The use of paste, gum, and smoke from leaves and pods has been reported as anticancer, antidiabetic, anti-inflammatory, and antimicrobial purposes³³. Fresh Leaves juice mixed with lemon juice issued for dyspepsia; extract of crushed pods is used for earache, toothache³⁴. The leaf paste applied on boils and blisters^{32,35}; leaf infusion on open sores on the skin³⁶. The stem bark has folkloric reputé to possess anti-inflammatory, antirheumatic, tonic, and vermifuge properties is reported to be used in the treatment of anxiety, asthma, bronchitis, dyspepsia, fever, dysentery, leprosy, piles, and tremors, asthma, bronchitis, dysentery, leukoderma, leprosy, muscle tremors and piles^{16,37,38}. The bark is used as a remedy for rheumatism, cough, common cold asthma and scorpion stings, and also against miscarriage^{39,40}. Sivarman et al⁴¹ studied detoxifying action of aqueous bark extract of *P. cineraria* (L.) against crude venom for Indian Cobra *Naja naja*. The ashes of bark are rubbed over the skin to remove hair^{42,43}. The flowers are used as an antidiabetic agent³⁸. The flowers are mixed with sugar and administered to prevent miscarriage^{44,43}. The smoke of the leaves is considered a good remedy for ailments of the eye^{31,32}. The immature and mature pods are energy rich edible and have high nutritional values for as a human diet in the various regions^{8,45}.

BIOACTIVITY STUDIES

Hydro-alcoholic extract of leaves and bark showed significant antitumor activity^{32,46}. Experimental liver tumors in rats⁴⁷ inhibited cell proliferation^{48,49} inhibited the proliferation of MCF-7 breast cancer cells^{49,37} reported antigenotoxic effects⁵⁰.

P. cineraria (L.) produce antibacterial properties⁵¹⁻⁵⁵. The antibacterial activity was tested against clinical isolate, the methanol extract showed better results against all pathogens in comparison to standard antibiotic drug²¹. Aqueous and chloroform extract of the unripe pods of did not showed any activity against *E.coli*, *P. aeruginosa* and *S. typhi*²¹. The ethyl ether and alcoholic extracts showed positive reactions against all *S. aureus*, *E. coli* and *Candida albicans*⁵⁶. The microbial activity has been reported due the to the presence of flavonoids and tannins⁵⁷.

P. cineraria (L.) has been shown protective role in reducing glucose levels as well as in increasing body weight⁵⁸, decreasing in the blood glucose⁵⁸, antihyperglycaemic activity^{22,58,59} decreasing the fasting blood glucose level in mice, and reducing the oxidative damage in the tissues of diabetic animals⁵⁸. Sharma and Singlas⁵⁹ reported that *Prosopis* extracts showed insulinogenic effect; and caused significant increase in the serum insulin levels⁴⁴.

Analgesic Activity and Antipyretic activity

Different extracts of leaves exhibited significant analgesic activity^{37,60} and antipyretic activity^{37,60,61}. Petroleum ether, ethyl acetate and ethanol extracts of stem bark showed a significant analgesic activity in experimental rats^{60,61}. Ethanol extract exhibited analgesic activity⁶² and significant anti-pyretic activity⁴⁴ as reported due to the presence of alkaloids, tannins, and steroids⁴⁴.

Methanolic extract of dried stem bark of *P. cineraria* (L.) showed improved nootropic activity in mice^{44,63}. Methanolic extract from

the stem bark exhibited spasmolytic, bronchodilator, and vasodilator activities in isolated rabbit tracheal preparations¹⁶. Methanolic extract showed significant reduction in duration of convulsions⁶⁴.

The hydro-alcoholic extract of stem bark showed antihypercholesterolemic activity in albino male New Zealand rabbit^{65,66,59}. Jain and Surana⁶⁷ reported hypolipidemic activity on the fruit extract and Sharma et al⁵⁸ reported on the bark extract.

The different solvent extracts of *P. cineraria* (L.) stem bark exhibited antihelminthic activity⁶⁸; significant antidepressant activity^{15,16} and estrogenic activity *in vitro*⁶⁹. The aqueous of *P. cineraria* (L.) leaves extract showed skeletal muscle relaxant action^{15,69}. The extracts of stem, leaf and bark of *P. cineraria* (L.) showed antioxidant potential^{37,70}; high antioxidant activity exhibited in pods⁵⁸⁻⁶⁹. The antioxidant activity of this plant is mainly due to the flavonoids, phenolic compounds⁵¹. The stem barks of *P. cineraria* (L.) exhibited significant antidiarrheal activity⁷¹, caused relaxation of the spontaneous contractions in isolated rabbit jejunum preparations having effective spasmolytic bronchodilator, and vasodilator activity⁴⁴. *P. cineraria* (L.) exhibited a marked dryness of wound margins with tissue regeneration, increased cellular proliferation contributed to healing process⁷². Implications of remarkable antivenom activity of aqueous bark extract of *P. cineraria* (L.) was used in identifying to various protein toxins present in the venom of Indian cobra⁴¹.

PHYTOCHEMICAL CONSTITUENTS/COMPOUNDS OF THE PLANT AND BIOACTIVITY

P. cineraria (L.) were investigated for various phytochemical constituents such as alkaloids, carbohydrates, steroids, proteins, phenols, tannins, flavonoids, glycosides, and saponins as per Indian Pharmacopoeia^{73,52,74,75}.

Seeds

The seeds contain protein, carbohydrates⁷⁶; seed protein is constituted of alanine, arginine, aspartic acid, glutamic acid, glycine-serine, isoleucine-leucine, histidine, lysine, methionine, phenylalanine, proline, threonine, tyrosine, valine, and traces of tryptophan^{5,77-79}; also contains fixed oils, fatty acid such as palmitic acid, stearic acid, oleic acid & linoleic acid, sterols like campstool, stigmasterol, β - sitosterol, stimasta-5, 24(28)-dien-3 β -ol, stimasta-1,3,5-triene, stimasta-4,6-dien-3-one⁷⁷. The seed lipids contain a relatively large proportion of unsaturated fatty acids, with linoleic and oleic acids being predominant⁷⁴. Seeds have been reported to contain the chemical compounds Prosogerin C, Prosogerin D, Prosogerin E, Gallic acid, patuletin, patulitrin, luteolin, and rutin³⁴; flavones from seeds^{74,75}.

Flowers

The isolation of a flavone glycoside Patulitrin 3, 5, 6, 3, 4-pentamethoxy-7-hydroxy flavone from flowers of *P. cineraria* (L.) has been reported⁴⁴. The presence of phytochemicals in *Prosopis* flowers that include Patuletin Glycoside patulitrin, luteolin and rutin sitosterol, spicigerine, and flavone derivatives Prosogerin A and Prosogerin B^{34,79-83}.

Leaves

Amino acids isolated from leaves are Aspartic acid, Glutamic acid, Serine, Glycine, Histidine, Threonine, Arginine, Alanine,

Proline, Tyrosine, Valine, Methionine, Cysteine, Isoleucine, Leucine, Phenylalanine and Lysine^{44,84}; phenolic acid derivatives^{82,85}. Garg and Mittal³⁴ reported that the leaves contain steroids like campesterol, cholesterol, sitosterol and stigmasterol, actacosanol, hentriacontane, methyl docosanoate, Diisopropyl-10, 11-dihydroxyicosane-1,20-dioate, Tricosan-1-ol, and 7,24-Tirucalladien-3-one along with a piperidine alkaloid spicigerine^{44,80-82,86}. The leaves also showed the presence of large proportion of unsaturated fatty acids, with linoleic acid and oleic acid⁸².

Pods

Fresh, ripe pods contain calcium and phosphorus⁷⁶. They are rich in carbohydrates³², a good source of protein, while fiber content are also good³². The dry pods reported to contain copper and manganese, zinc⁷⁶, yielded fatty oils⁷⁶. Dried pods also contains 3-benzyl-2-hydroxy-urs-12-en-28-oic acid, maslinic acid 3-glucoside, linoleic acid, prosophylline, 5,5'-oxybis-1,3-benzendiol, 3,4,5, trihydroxycinnamic acid 2-hydroxy ethyl ester, and 5,3',4'-trihydroxyflavanone 7-glycoside⁸⁷. When the boiling water extract of the pods is fractionated using methanol and trichloro methane, it results in the isolation of compounds such as 3-benzyl-2-hydroxy-urs-12-en-28-oic acid and maslinic acid-3-glucoside (triterpenoids); linoleic acid (fatty acid); prosophylline (piperidine alkaloid); 5,5'-oxybis-1,2-benzanediol; 3,4,5-trihydroxycinnamic acid 2-hydroxyethyl ester; and 5,3',4'-trihydroxyflavanone 7-glycoside (polyphenols)⁶⁹. Various phytoconstituents like tannins (gallic acid), steroids (stigma sterol, campestral, sitosterol, etc.), Flavone derivatives (prosogerin A, B, C, D, and E), alkaloids (spicigerine, prosophylline), etc. have been isolated from the *Prosopis* pods³¹. Dried unripe pods of *P. cineraria* showed the presence tannins, alkaloids, flavonoids and glycosides in the dried unripe pods²¹.

Bark

The bark of *Prosopis* has been reported for the presence of glucose, rhamnose, sucrose and starch by several researchers^{44,80-82}. The chloroform extract the compounds isolated from bark of *P. cineraria* (L.) reported Methyl 5-tridecyloctadec-4-enoate, nonacosan-8-one, lupeol, β -sitosterol and stigmasterol⁸⁸.

BIOACTIVE COMPOUNDS AND THEIR ACTIVITY

The Phytochemical and Ethnobotanical Database⁸⁹ includes the report on the Phytoconstituents of *Prosopis* sp. have been reported to be allied with various bioactivities eg., 5-hydroxytryptamine (antidepressant, antibacterial), apigenin (antidermatic, antiviral, anti-inflammatory), isorhamnetin-3-diglucoside (hepatoprotective), L-arabinose (analgesic, antiallergic), quercetin (antibacterial, antidiabetic, antiviral, anti-inflammatory), tryptamine (antiamoebic, antibacterial) and Tannin from the bark (antiarrholic, antiviral activity).

The presence of flavonoids, glycosides and phenolic contents from *P. cineraria* (L.) extract has hypolipidemic potential against hyperlipidemia⁹⁰; steroids like campesterol, cholesterol, sitosterol and stigmasterol, actacosanol, hentriacontane, methyl docosanoate, diisopropyl-10, 11-dihydroxyicosane-1,20-dioate, tricosan-1-ol, 7,24-tirucalladien-3-one along with a piperidine alkaloid spicigerine^{79,82}. Patulitrin isolated from flowers exhibited cytotoxic active against Lewis lungs carcinoma *in vivo*³⁴. Rutin exhibited anti-inflammatory activity. Luteolin showed anticancer activity⁹¹. The compounds belong to triterpenoids, fatty acid, piperidine alkaloid and

polyphenols have been studied to determine their antioxidant and anti-inflammatory activities⁸⁷. Luteolin inhibit may inhibit skin cancer mechanisms *in vitro* and *in vivo*⁹². Hydrocinnamic acid and coumaric derivatives have been reported to possess antioxidant properties and are believed to reduce the risk of stomach cancer by reducing the formation of carcinogenic nitrosamines⁵⁰.

SAFETY STUDIES OF THE PLANT

50% Hydro alcoholic extract of the leaves and stem bark showed No mortality recorded within 24 h. No significant changes in behavior, breathing, cutaneous effects, sensory nervous system responses. The extracts did not produce significant changes in hematological parameters compared to the control⁷⁷. Methanolic extract of the leaves was found safe at 100mg/kg body weight⁹³. Methanolic extract LD₅₀ was reported to be 122.47 mg/kg body weight⁶². The leaves extract was found to be safe up to maximum dose of 2 g/Kg body weight of the rats⁷². Hydro- alcoholic extract of the leaves and bark showed LD₅₀ higher than 2000 mg/kg⁷⁷. Aqueous extract of the bark was reported to be safe⁴¹. Methanolic extract of the leaves showed significant decreased the viability of the cells⁴⁸, the Flavoneglycoside Patulitrin from the flowers exhibited cytotoxic activity⁵.

FUTURE PROSPECTIVE

The current trend of increasing use of herbal medicines and their growing popularity all over the world, the search for drugs and dietary supplements derived from plants have accelerated in recent years. The increasing use and fast-growing market of herbal medicines and widespread use of herbal medicines is likely to increase even further throughout the world in the coming years with more and more scientific evidence of their quality, efficacy and safety coming from the researchers. The available data on *P. cineraria* (L.) can provide evidential support for the clinical development of *P. cineraria* (L.) as adjuvant therapy. We believe *P. cineraria* (L.) fulfils the criteria for its selection of the plant based on its therapeutic potential and toxicity profile, and also availability of the plant. It is observed from various studies that the *P. cineraria* (L.) have a number of pharmaceutical and medicinal property and according to this; it is effective in the treatment of a number of chronic diseases. We hope the therapeutic potential of *P. cineraria* (L.) could be best connected, towards a possible integration into the healthcare system.

CONCLUSION

P. cineraria (L.) is well-adapted to extreme environmental conditions grows in wide geographic range. It can be concluded that *P. cineraria* (L.) is promising medicinal plant having wide ranges of pharmacological activities and used traditionally *viz*, antioxidant, antimicrobial, anti-diabetic, hypertension, hepatotoxicity, lipid lowering activity, anti-inflammatory, anticancer potential. In addition to their medicinal importance, *P. cineraria* (L.) has significant nutritional importance. The present review is aimed to summarize the up-to-date information on the traditional uses, pharmacological activities and phytochemistry of *P. cineraria* (L.). The researchers reported numbers of new activities and hence the plant is now achieving importance place to work for further search, considering its versatile medicinal uses, there is an ample scope for future research on *P. cineraria* (L.). Despite progress in conventional chemistry and pharmacology in producing effective drugs, the plant kingdom might provide a useful source of new medicines and may be used in place of existing drugs.

TABLE I: BIOACTIVITY OF *P. cineraria* (L.)

Bioactivity	Extract	Parts used	Effect	Reference
Cytotoxicity/ Antitumor activity	Secondary metabolite	Leaves	Exhibits cytotoxic activity.	46
	Hydro alcoholic extract	Leaves	Possessed significant cytotoxicity towards EAC tumor cells.	77
	Hydro- alcoholic extract	Leaves	Reduced Glutathione when compared to liver tumor bearing animals. The extract also increased the levels of mitochondrial enzymatic antioxidants superoxide dismutase, catalase and glutathione peroxidase and non-enzymatic antioxidants	47
	Crude extract	Leaves, stem, flowers and root	Showed and weak toxicity.	94
	The silver and copper nanoparticles From leaf extract.	Leaves	MTT assay results indicated that nanoparticles show potential cytotoxic effect.	95
	Methanolic extract	Leaves	Inhibit the proliferation of MCF-7 breast cancer cells producing apoptosis.	49
	Methanolic extract	Leaves	Showing protective role by modulating the levels of membrane bound enzymes and suppressing glycoprotein levels.	96
Atihyperglycemic activity	50% Hydro-alcoholic extract	Stem bark	Fasting blood glucose level decreased by 27.3%, comparable to that of standard Glibenclamide, which produced 49.3% reduction and liver glycogen content was significantly increased as compared to control group.	58
	Hydro- alcoholic extract; Aqueous extract		Protective role in reducing glucose levels as well as in increasing body weight.	59
	Hydro- alcoholic extract	Stem bark	Fasting blood glucose level decreased comparable to that of standard Glibenclamide drug.	59
	Stem bark extract	Stem bark	Significantly reduced the glucose level	44
Hypolipidemic activity/ Antihyperglycemic activity	70 % ethanol	Fruit extract	Showed anti-hyperlipidemia and antioxidant activities.	67
	Methanolic extract	Leaves	Caused a significant increase in HDL level; Produced antidiabetic effect in Wistar rats;	97
	70% Ethanol extract	Stem bark	Significantly reduced serum total cholesterol , LDLC , triglyceride , VLDL-C and also Total cholesterol/LDL-C and LDL-C/HDL-C Cholesterol and triglycerides.	66
Antihyperlipidemic in diabetic rats	Aqueous extract	Leaves	Blood glucose levels were significantly decreased; Significant increase in lipids level except HDL	59
	Hydrochloric acid extract	Bark	Shows dose dependent effect on the lipid profile, higher dose shows significant action over Triglyceride, Cholesterol, and also increase the level of the HDL	59
Hyperlipidemic effect	Dietary fiber	Fruit	The dietary fiber influenced total lipids, cholesterol, Triglycerides and Phospholipids of the liver to varying extents.	98
Antihyperglycemic/ antihyperlipidemic/ antioxidative potential	Ethanolic extract	Bark	Showed anti-diabetic and antioxidant efficacy	58
Antidiabetic and antioxidant activity	Ethanolic extract	Fruit extract	Hypolipidemic effects in HFD-induced hyperlipidemic rats via modulation of elevated oxido-nitrosative stress.	67
Analgesic Activity	Aqueous extract and ethanolic extract	Leaves	The significant analgesic activity exhibited as compared to control.	37
	Petroleum ether; ethyl acetate and ethanol extracts	Stem bark; Root	Ethanolic extract showed a significant analgesic activity at a dose of 300 mg/Kg B.W. in rats.	61
	Aqueous extract/ ethanolic extract	Root	Exhibited analgesic activity in albino mice was significant as compared to control.	60
Antipyretic activity	Aqueous extract	Root	Exhibited a significant antipyretic activity at same dose using Brewer's yeast induced hyperpyrexia mode.	60
	Petroleum ether extract	Different extracts	Exhibited significant anti-pyretic activity, when compared with other extracts.	44
	Aqueous extract	Leaves	Exhibited a significant antipyretic activity.	37
Antipyretic activity/ analgesic activity	Petroleum ether, ethyl acetate and ethanol extracts	Stem bark	Exhibited a significant antipyretic activity.	61
Brochiodialator activity 1.	Methanolic extract	Stem bark	The extract exerted a concentration-dependent relaxant effect on carbachol and K ⁺ -induced contractions in isolated rabbit tracheal preparations.	42
	Methanolic extract	Plant Extract	The extract shows concentration dependent relaxant effect on both carbachol and K ⁺ induced contraction; causes blockade of the Ca ⁺ channel hence it also provides the vasodilatory effect.	16

Anticonvulsant activity	Methanolic extract	Plant extract	Showed significant anticonvulsant activity; Inhibition of the maximum electro shock is observed against generalized tonic-clonic and cortical focal seizure.	64
Antihelminthic Activity	Different extract	Stem bark	Exhibited antihelminthic activity in a dose dependent manner in <i>Pheretima posthuma</i>	68
	Aqueous extract	Leaves	Exhibited significantly decreased the duration of immobility time in Forced swim test.	15
	Aqueous extract	Leaves	Showed significantly decreased the duration of immobility; comparable to that of imipramine	47
	Aqueous extract	Leaves	Produced significant antidepressant effect and the efficacy is similar to antidepressant drug Imipramine.	16
Estrogenic activity	Methanolic extract	Pods	Exhibited estrogenic activity in vitro.	99
Skeletal Muscle Relaxant Activity	Aqueous extract	Leaves	Exhibited muscle relaxing activity	69
	Aqueous extract	Leaves	Exhibited significant skeletal muscle relaxant activity	15
Antioxidant activity	Petroleum ether, Benzene, Chloroform, Ethyl Acetate, Methanol and Aqueous Extract	Leaves	All fractions showed to have scavenging activity. The ethyl acetate and methanolic extracts showed to have maximum scavenging activity while petroleum ether has minimum scavenging activity.	37
	Ethanol extract	Stem, Leaves, Bark	Exhibited antioxidant potential. The percentages of antioxidants are 82.19%, 71.16% and 89.92% in stem leaf and bark extract respectively against the standard, which was ascorbic acid with antioxidant activity of 96.00%.	51
	Methanolic extract	Leaves	Improved the antioxidant status of the goat liver slices and also protected against Oxidative damage.	48
	Methanolic extract	Pods	High antioxidant activity has also been exhibited by the methanolic extract of its pods.	69
	50% Hydro-alcoholic extract	Stem bark	Reduced activity of antioxidant enzymes, thereby reducing the oxidative damage in the tissues of diabetic animals and hence indicating anti-diabetic and antioxidant efficacy of the extract.	58
Wound healing activity	Ethanol extract	Ethanol extract	Exhibit marked dryness of wound margins with tissue regeneration. Increased cellular proliferation was found as compared to control values.	72
Nootropic activity	Methanolic extract	Stem bark	Significantly improved both spatial reference and working memories in the spatial working memory.	63
Antidiarrheal studies	Methanolic extract	Stem bark	Exhibited dose dependent antidiarrheal effects in the all treated groups and the results were compared with that of loperamide as reference standard drug.	71
Spasmolytic bronchodilator and vasodilator activity.	Methanolic extract	Methanolic extract	The extract caused a complete relaxation of carbachol and high K ⁺ - induced contractions in isolated rabbit tracheal preparation in concentration-dependent manner; produced spasmolytic bronchodilator and vasodilator activity.	42
Anti-venom activity	Aqueous, methanol and petroleum ether extracts	Root	The aqueous extract at the dose of 14 mg/kg b.w. was able to almost completely neutralize the lethal activity crude venom of <i>Naja naja</i> .	100
Depilatory activity	Herbal formulation	Leaves	Cream was found depilatory	43
Antimicrobial activity	The silver and copper nanoparticles using microwave irradiation.	Leaves	Showed antimicrobial activity against Gram-positive. and Gram-negative. MTT assay results indicated that both nanoparticles show potential cytotoxic effect against breast cancer cells (MCF-7).	95
	Different extracts of dried unripe pods	Pods	Methanolic extract shows significant results on all pathogens whereas no activity was recorded by petroleum ether extract. Among the tested four gram negative bacteria, (<i>E.coli</i> , <i>P.aeruginosa</i> and <i>S.typhi</i> , <i>K.pneumoniae</i>) <i>K.pneumoniae</i>).	51
	The methanolic and aqueous extracts of the stem bark	Stem bark	The methanolic and aqueous extracts exhibited moderate antibacterial activity using Agar well diffusion method	57
	Acetone extract	Aerial parts	Exhibited moderate antibacterial activity against three bacterial strains <i>Staphylococcus aureus</i> , <i>Staphylococcus epidermidis</i> and <i>Escherichia coli</i> using Agar well diffusion method	52
	Methanolic extract	Leave	Showed moderate antibacterial activity against <i>Bacillus subtilis</i> , <i>Escherichia coli</i> , <i>Vibrio cholera</i> and <i>Enterobacter aerogenes</i> using Agar disc diffusion method	53
	Methanolic extract and Aqueous extract	Stem bark	Methanolic extract shows significant action on all pathogen using Agar disc diffusion method	54
	Ethyl acetate and hydro-alcoholic extracts	Stem bark	Exhibited dose dependent activity against the microorganisms against two Gram positive (<i>Staphylococcus aureus</i> , <i>Staphylococcus epidermidis</i>), two Gram negative (<i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i>) using Agar disc diffusion method. Minimum Inhibitory Concentration	55
	Ethyl ether and Alcoholic extract	Leaves	Showed positive reactions against micro-organisms <i>Staphylococcus aureus</i> (Gram positive), <i>Escherichia coli</i> (Gram negative) and <i>Candida albicans</i> .	56

	Extract of <i>P. cineraria</i>	Leaves	Shows significant antimicrobial activity against multidrug resistant bacterial and fungal strains	101
	Various extract	Stem bark	Moderate antibacterial activity was observed in the extract against <i>Salmonella Staphylococcus Bacillus Escherichia Pseudomonas</i>	57
	Methanolic extract	Leaves	Exhibited significant activity using MICs method.	102
	Extraction of essential oil	Leaves	Significant antifungal activity on <i>Fusarium solani</i> , <i>F. oxysporum</i> , <i>F. pallidroseum</i> , <i>F. acuminatum</i> and <i>F. chlamydosporum</i> .	103

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