Comprehensive Review on Phytochemistry, Ethnobotanical, Bioactivities and Medicinal Mysteries of *Ougeinia oojeinensis* (Roxb.) Hochr

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Article Information

Received 2 Nov 2019

Received in revised form 22 March 2020

Accepted 27 March 2020

Keywords:

Ougeinia oojeinensis,
Fabaceae,
Secondary metabolites,
Desmodium oojeinense,
Ougeinia dalbergioides

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DOI: [10.20510/ukjpb/8/i2/1586230488](https://doi.org/10.20510/ukjpb/8/i2/1586230488)

Abstract

Various parts of plants such as leaf, stem, roots and barks were used as medicines in aayurveda, siddha, unani and homeopathic treatments. As only few studies are done on such plant, the purpose of this current review is to make accessible till date information on, botany, morphology, ecological biodiversity, therapeutic uses, phytochemistry and pharmacological activities on diverse parts of *Ougeinia oojeinensis*. This review was assembled using technical literature from electronic search engine such as Springerlink, BioMed Central, PubMed, Scopus, ScienceDirect, Scielo, Medline and Science domain. Supplementary texts were obtained from books, book chapters, dissertations, websites and other scientific publications. *O. oojeinensis* commonly known as Tinsa, is rich in secondary metabolites, which impart incredible medicinal uses to the plant. The active constituents extracted from *O. oojeinensis* are genistein, ougenin, dalbergioidin, kaempferol, lupeol, Ferreirin, neophellamuretin, orobol, wedelolactone, homoferririn isoflavanone and betulin etc. The uses of bark are astringent, acrid, cooling, stimulant, anti-inflammatory, constipating, anthelmintic, sudorific, depurative, urinary astringent, styptic, febrifuge and rejuvenating. The extract of the whole plant showed anti-inflammatory, hypotensive action, antioxidant activity, hepatoprotective, anthelmintic, hypoglycemic and wound healing activities. There is a need to isolate the active constituents, their biological test, experimental defense, molecular mechanisms and legalization of there therapeutic uses of *O. oojeinensis*. The gathered detail will be obliging to determine the study protocol for current drugs and Ayurvedic formulation extension in the remedial and luxury a variety of ailments. Clinical trials for the reported preclinical studies should be executed immediately to further validate the claims on humans.

1 Introduction

Herbal formulations are medicinal preparation of one or more herbs present in specified quantities to give the benefits meant for cosmetic, diagnose and to mitigate diseases of human beings or animals¹. It is well known as botanical medicine or phytomedicine. Earlier in twentieth century, the herbal medicine was found to be the prime medication system as antibiotics or analgesics were inaccessible. Increasing in the use of an allopathic system of medicine due to its high therapeutic effect and herbal medicine slowly lost their popularity among the common people. For example, Curcuma is used traditionally in

Chinese Medicine for more than two thousand years to cure anti-inflammatory and robust antioxidant^{2,3}. About 70-80% people are still consuming herbal medicine for their primary health because of the minimum side effect and better consistent with the human body⁴

Herbal medicine has gained momentum and is more effective as compared to synthetic drugs. Medicinal plants form a huge group of inexpensively significant plants that provide the essential raw materials for indigenous pharmaceuticals⁵. Plant products still remain the most important source of pharmaceutical agents used

in conventional medicine⁶. According to the WHO the primary step for recognition and purification of herbal drugs is the pharmacognostic (macroscopic and microscopic) studies which are necessary for any phyto pharmaceutical products used for standard formulation⁷. Preliminary phytochemical studies are obliging in finding out chemical constituents in the plant material that may fine lead to their quantitative estimation^{8,9}. Lately more concentration has directed towards the extracts and bioactive compounds are isolated from accepted plant species. In the current age of drug development and newly discovered drug molecules, a lot of plant products are judgeon the basis of their ordinary uses.

The healing ability of medicinal plants are due to the occurrence of various multifaceted chemical substances of different compositions which happen as secondary metabolites¹⁰. The most significant of these bioactive constituents of plants are steroids, tannins, alkaloids, flavonoids and phenolic compounds. Therefore, it is enviable to know the phytochemical constituents of plant material before checking its effectiveness for the medical purpose. Plants are also main natural sources of medicinal compounds in the present pharmacopoeias¹¹. Indian Material

Medica consist about 2000 drugs of natural origin and most of them are leading from various conventional system and myths practices¹². However, there are large numbers of plants, which have not been mentioned in these reports, in malice of their usage in the conventional and folk medicinal systems.

O. oojeinensis belongs to the family Fabaceae (Fig 1). It is a valuable timber and fodder species restricted to India mostly in the outer Himalayas and sub-Himalayan tracts from Jammu to Bhutan. The natural forests containing this tree have been severely degraded by timber exploitation. Commonly it is known as Tinsa, Sandan, Panjan^{13,14}. The extract of the complete plant of *O. oojeinensis* were used as anti-inflammatory, analgesic, hepatoprotective, antioxidant, anthelmintic, antidiabetic hypoglycemic and wound healing activity. Phytochemical investigation on the *O. oojeinensis* have reported the existence of lupeol, hydroxlupeol, betulin and isoflavanones such as dalbergioidin, homoferreirin and ougenin. The bark and leaves are used in the cure of jaundice, diabetes dysentery, urorrhagia, verminosis, leprosy, diarrhoea, leucoderma, haemorrhages, fevers, ulcers etc¹⁵.

Fig 1: *Ougeinia oojeinensis* (A) Plant, (B) Leaves, (C) Bark

The systemic classification of *O. oojeinensis* consists of domain: Eukaryota, Kingdom: Plantae, Subkingdom: Phanerogamia, Division: Angiospermia, Phylum: Tracheophyta, Class: Dicotyledons, Sub-Class: Calyciflora, Order: Fabales, Family: Fabaceae and Synonyms: *Desmodium oojeinense* (Roxb.) H. Ohashi, *Ougeinia dalbergioides* Benth.

The vernacular names of the plant are Hindi: sandam, terrichcha, sandan, timsa, tinnas, tinsa, Kannada: kari-mutal, Kurimutala, Marathi: syandan, kaala palaas, kalapalas, tanach, tewas, thanach, Sanskrit: sejanduna, tinisa-segandun, trinisha, tinisa, tinisa sejanduna, akshaka ect, Telugu: tella-motuku, adavickkudu, atimuktamu, nemmichettu, Malayalam: malavenna, malahonne, nemi, totukara, Tamil: narivengai, naiponai, tella-motuku, Tibetan: ti ni sa, Bengali: pandan, bandhan. Therefore, in this study, the ethnopharmacological review of *O. oojeinensis* was carried out aimed at providing a

detailed précis of the botany, ethnomedicinal uses, pharmacological activities and chemical composition of the species.

2 Research methodology

To recognize pertinent information on the phytochemistry, botany, medicinal uses and biological activities of *O. oojeinensis*, a review was amassed based on scientific literature from a variety of sources including Google Scholar, Science Direct, PubMed, Scielo, Springerlink, Google Patents, Web of Science, SciFinder, Scopus, Espacenet, BioMed Central (BMC) and Medline. The keywords used for recognition of relevant data included dissimilar scientific name and synonyms, common English names, and the terms: biological activities, ethnobotany, medicinal uses, medicinal, ethnopharmacology, pharmacology, phytochemistry and therapeutic value, *O. oojeinensis*, *Desmodium oojeinense* (Roxb.) H. Ohashi, *Ougeinia*

dalbergioides Benth, tinsa, sandan ect. Further literatures were finding from books, book chapters, theses, websites and conference proceedings.

3 Occurrence and distribution

O. oojeinensis found in the outer Himalayas and sub-Himalayan tracts from Jammu to Bhutan up to an altitude of 1500 m and extending through the whole of northern and central India into the greater part of Deccan peninsula. It is an important species in Uttar Pradesh and Madhya Pradesh¹⁶.

4 Ecology

O. oojeinensis is native to sub-tropical regions of the India. It is commonly found in elevations of 300-1500 m. At higher elevations they remains a small tree. The best mean annual temperature in its habitat ranges varies from 20-47 °C with a relative humidity from 49-90%. The most rainfall takes place in the range from 950-1900 mm. This species is not easily available in wet regions. Characteristic of limestone soils, sandan grows best on dry exposed sites and eroded hills¹⁷. It also occurs on red clay, black cotton, alluvial soil and rocky soil. Its optimum growth and greatest size is attained in the lowlands on alluvial soils. Sandan is a part of mixed deciduous and sal (*Shorea robusta*) forests. It is combined with pines at the higher limits of its elevation range.

5 Morphology

O. oojeinensis is a medium sized semi-deciduous tree, commonly obtain 40-50 cm in diameter breast height (DBH) and 7-14 meters in height¹⁷. The stem is many time crooked, but in some areas the tree is straight. The bark is changing from its pale pinkish-brown to dark bluish gray, is a little rough and exfoliates in uneven thin soft scales. Leaves are generally pinnately trifoliate, smooth above and lightly pubescent below the obovate leaflets are generally 6-12 cm long and 2-15 cm wide, but the size differ greatly and entire Leaf margins.

The light-pink to white flowers appear in the clusters from February to May. The preceding years branches mostly do not bear flowers. Branches bearing flowers are leafless, while remaining retain leaves. Flowering trees are conspicuous and afford beautiful sight. Pods have a distinct seam, are 5-10 cm long and 1 cm wide. They mature and become ripen in May to June and fall chiefly in June. Normally, pods remain closed until seeds germinate. Mature pod yields 2-5 viable seeds. The smooth brown seeds are 10-12 mm long and 5 mm wide. Trees do not seed heavily each year¹⁷.

6 Microscopic characters

The transverse section of bark shows outer region of rhytidome is made up of 6 to 7 rows of rectangular cells of cork, followed by 2 to 3 rows of groups of stone cells and sclerides. Pentagonal, hexagonal or polygonal cells of rhytidome traverse with different groups of thin walled fibres, compressed phloem, groups of

empty resin duct and biseriate medullary rays. Medullary rays and Parenchymatous cells embedded with starch grains and have prismatic calcium oxalate crystals. Rhytidome differing with 6 to 8 layers of irregular, lignified cell of powdery layer, followed by 6-7 covering of rectangular cells of cork. Below this group 2-5 covering of a stone cells were observed. Secondary phloem consist of somewhat polygonal to oval shaped cells traverse with different groups of thin walled fibres, groups of resin duct, compressed cells of biseriate medullary rays and phloem.

Phloem parenchyma and medullary rays embedded with simple, compound, oval starch grains and prismatic crystals of calcium oxalate¹⁸. The root is circular in sectional view has thin epidermal layer with prominent cuticular layer. The cortex is homogenous and parenchymatous. The cells are thin walled and loosely arranged. Tannins and crystals are abundant in the cortical cells. The vascular system consists of central two or three small masses of xylem elements and thin layer of phloem elements. Outer to the central masses occur as continuous wide cylinder of xylem and phloem. The xylem cylinder has several radial chains of thick walled angular vessels and thick walled lignified fibers. Outer to the xylem cylinder is completely ensheathed by thick sclerenchyma boundary within the phloem zone; there are wide, circular secretory cavities. Calcium oxalate crystals are fairly common in the cortical cells. The crystals are "prismatic type" of rectangular, cuboidal and double pyramidal¹⁹.

7 Phytochemical constituents

Leaves and heartwood contained the dalbergioidin, homoferreirin and ougenin. Leaves, in addition, contained quercetin, kaempferol and leucopelargonidin. Stem bark gave the lupeol and betulin. The bark contains 7% tannins. It also contains Genistein, Ferreirin, neophellamuretin, orobol, wedelolactone¹⁶.

8 Medicinal/ traditional uses

O. oojeinensis yields a valuable timber. Wood air seasons slow without more degradation. The wood does not require preservative treatment. It is little difficult to work, but turns well and readily takes polish. Though originally considered it is difficult to peel, it is now frequently utilized for the plywood²⁰. The leaves are highly valued as cattle feed. Leaves contain 12- 15% crude protein²¹. The bark is used as a fish poison and to reduce fevers. A plant fluid exudate is used to make a medicine to treat dysentery. The tree is a host plant for lac producing insects. The resulting shellac is of good quality²².

In an Ayurvedic texts, Tinishaa was used for alleviating burning syndrome during illness, while Tinisha was administered for urinary disorders, skin diseases, anaemia, and for treating obesity. It was also called as Atimuktaka, the drug for reducing obesity, which has now been equated with Hiptage benghalensis. Charaka prescribed fresh juice of bark and stalks, in prescriptions, internally for fevers, debility and as tonic for recuperation. Sushruta administered the drug internally in

obesity, jaundice, urethral discharges, chronic skin diseases; oil of the seeds as a digestive in bilious affections. A decoction of Tinisha, in combination with other intestinal antiseptics and astringents, was administered in haemorrhagic diarrhoea and dysentery. In folk medicine, the bark is used as a febrifuge. A kino-like exudation from the incised bark is used in diarrhoea and dysentery¹⁶. The juice of the root, mixed with the powder of two fruits of black pepper, is taken in cases of eye trouble. The stem bark is acrid, antiinflammatory, antispasmodic, astringent, cooling, depurative, febrifuge, hypoglycemic, hypolipidemic, rejuvenating, styptic and sudorific. It is useful in the management of diabetes²³.

9 Propagation

Ougeinia dalbergioides is generally propagated from seed. The seeds do not retain their viability for more time and should be used within 12 months of maturity. Once gathered seed should be dried properly and stored in well sealed containers. A kilogram contains 28,000-33,000 seeds. To increase germination, pods should be broken into small fragments containing one seed and absorbed in water for 1 day before sowing²⁴. Seed should be sown 1 cm deep. Germination occurs in 3-8 days. Direct sowing is very successful and highly recommended^{17, 25}.

10 Reported pharmacological activity

10.1 Anti diabetic activity

Velmurugan et al evaluated the hypoglycemic and hypolipidemic action of extract of ethanol *Ougeinia oojeinensis* (200mg/kg) bark with measurements including, body weight, blood glucose level, urine glucose level and biochemical parameters. The ethanolic extracts of powdered bark was checked for its efficacy in alloxan-induced diabetic rats. The extracts showed significant ($p < 0.01$) hypolipidemic action and antihyperglycemic action as compared to diabetic control. The constituents shows important action on blood glucose and urine glucose level. It also reduces the elevated biochemical parameters, which might be due to presence of steroids, tannins, alkaloids and triterpenoids present in that extract. Thus ethanolic constituent could be served as best oral hypoglycemic agents and seems to be promising for development of phytomedicines for the diabetes mellitus²⁶.

Samyal et al extracted different parts from *O. oojeinensis* bark extracts and evaluated the effect of antidiabetic activity of fractions. The nine several fractions were gathered from ethanol extracts of *O. oojeinensis* bark. The fraction F4, F6, F7 and F8 were administered orally in Streptozotocin (STZ)-induced diabetic rats. After the administration of fractions, blood glucose amount were monitored at specific intervals of time and it was found that they were significant lowered. Glibenclamide was used as a high quality drug at a dose of 0.50 mg/kg body weight. The findings demonstrated that parts isolated from ethanol extracts of *O. oojeinensis* bark has significant antidiabetic activity in streptozotocin-induced rats compared to high quality drug²⁷.

Samyal et al investigated the antidiabetic activity of *Ougeinia oojeinensis* bark and root extracts. The different doses of ethanol extracts of bark and root were administered orally in Streptozotocin (STZ)-induced diabetic rats. After the entering of extracts, blood glucose levels were observed at specific intervals of time and it was observed that they were significantly lowered. Glibenclamide was used sometimes as a high quality drug at a dose of 0.50 mg/kg body weight. The experimental data revealed that extract has significant activity of antidiabetic in streptozotocin-induced rats as compared to standard drug²⁸.

10.2 Antimicrobial activity

Mandrekar et al tested antimicrobial activity of ethanolic constitute of stem bark of *Ougeinia oojeinensis* using agar diffusion method against 10 bacterial and 1 fungal strains. The ethanolic extract was found to have significant antimicrobial activity against all tested microbes and particularly against *Salmonella typhimurium* and yeast strain *Candida albicans*. The traditional claim that use of this plant bark has curative properties has some merit in view of the fact that the extract has phyto-constituents with potential anti-candidiasis and anti-salmonella properties²⁹.

Singh and Gupta evaluated the antimicrobial action and phytochemical of the methanol and aqueous extracts of leaves of *Ougeinia oojeinensis*. The antimicrobial activity and minimum inhibitory concentration (MIC) of the methanol and aqueous extract of *Ougeinia oojeinensis* leaves was checked by agar diffusion method. levels of Inhibition produced by two extract in a dose from 50 and 200 mg/ml against taken strains was observed and differentiated with those of standard drug ciprofloxacin. Both extract recorded significant activity against all the test bacteria. The maximum antimicrobial activity was exhibited by methanol extract against all the microorganisms compared to be aqueous extract³⁰.

10.3 Anti-oxidant activity

Jayadevaiah et al evaluated the in vitro anti-oxidant activity of ethanolic constituent of the stem bark of *Desmodium oojeinense* by different technique namely total reducing power, nitric oxide radical scavenging activity and 1,1-diphenyl 2 picryl hydrazyl (DPPH) radical scavenging activity. The extract showed significant percentage of inhibition in dose dependent manner compared to standard antioxidant sodium meta bisulphate. Our findings give evidence that crude ethanolic extract of stem bark of *Desmodium oojeinense* is a rich source of natural antioxidant³¹.

Kumar et al evaluated different extracts of seeds of *Ougeinia oojeinensis* for their membrane stabilizing and antioxidant effects. The Fatty acid composition was also estimated. Membrane stabilizing effect was studied by hypotonic solution induced haemolysis of erythrocyte. Antioxidant activity was studied by DPPH method at a different concentration. GCMS

assay was generally done for petroleum ether extract with the help of Perkin Elmer Clarus-500 model coupled with CLARUS-500 Mass spectrometer. Phytochemical analysis showed that methanol extract was the richest extract for the tested phytoconstituents. Different fatty acids were present in petroleum ether extract which was analyzed by GCMS. Maximum membrane stabilizing activity of seeds of *Ougeinia oojeinensis* showed in Methanol extract (81.41 ± 1.28) at a concentration of $1000 \mu\text{g/ml}$ in comparison to standard drug aspirin. From antioxidant studies, methanol extract showed maximum antioxidant activity (91.31 ± 1.31) at a concentration of $1000 \mu\text{g/ml}$ than other extract in comparison to standard drug ascorbic acid³².

Sahu et al evaluated the antioxidant activity of ethanolic bark constituent of *Ougeinia oojeinensis* on the CCl_4 -induced liver injury in rats. In hepatotoxic rats, liver injury was studied by checking different parameters such as catalase activity, lipid peroxidation, levels, glutathione peroxidase action and superoxide dismutase actions were employed as biomarkers of liver damage, under the controlled condition and after the administration of 100 mg/kg and 200 mg/kg, respectively. Our result suggests that the ethanolic bark extract of *O. oojeinensis* showed a significant antioxidant action. Superoxide dismutase, catalase and glutathione peroxidase activity were increased, where as the lipid peroxidation is significantly reduced in the ethanolic barks extract-treated group, in compare to the CCl_4 group. Therefore the ethanolic bark extract, at the aforementioned doses, showed the important protection under the CCl_4 -induced hepatocellular injury³³.

Singh et al evaluate in-vitro antioxidant action of the methanol and the aqueous extracts of leaves of *Ougeinia oojeinensis*. The antioxidant action of the in vitro was measured by means of the 1, 1-diphenyl-2-picrylhydrazyl (DPPH), nitric oxide (NO) and superoxide (SOD) free radical scavenging assays. The methanol and water extracts exhibited scavenging effect with IC_{50} values of 125.31 and $146.12 \mu\text{g/ml}$ respectively for DPPH radical and $189.75 \mu\text{g/ml}$ and $223.77 \mu\text{g/ml}$ for inhibition of nitric oxide respectively. The methanolic extract and aqueous extract has scavenging superoxide free radical with the IC_{50} values of 177.85 and $214.69 \mu\text{g/ml}$ respectively. All the characteristic were found to be dose dependent³⁴.

10.4 Hepatoprotective activity

Sahu and Roy examined the hepatoprotective effect of bark of ethanol extract of *Ougeinia oojeinensis* in male wistar albino rats treated with carbon tetrachloride. Liver injury was studied by assessing different parameters such as serum glutamate oxaloacetate transaminase, glutamate pyruvate transaminase, acid phosphatase, alkaline phosphatase and bilirubin in serum. The action of administered ethanolic extract at dose of 100 mg/kg and 200mg/kg on the high parameter was further investigated. Results of such study revealed that the suspension of ethanolic extract showed significant hepatoprotective activity ($P < 0.05$) by

reducing the steps of the biochemical parameters in experimental animals. The ethanolic extract of both doses afforded significant protection against CCL_4 induced hepatocellular damage. Histopathological studies too, are in conformity with findings³⁵.

Jayadevaiah et al investigate the hepatoprotective action of ethanol extract of stem bark of *Desmodium oojeinense* hepatotoxicity in wistar rats. The hepatoprotective action of the ethanol extract was assessed in CCl_4 induced hepatotoxic rats. Change in injury like SGOT, SGPT, ALP and total bilirubin level were assayed in both CCl_4 untreated and treated groups. CCl_4 has increased the SGOT, SGPT; an ethanolic extract of *Desmodium oojeinense* has brought back the altered levels of biochemical markers to the near normal levels in the dose dependent also provided supportive evidence for biochemical analysis. Silymarin (100 mg/kg) was given as a standard hepatoprotective drug³⁶.

Jayadevaiah et al investigated the hepatoprotective activity of ethanolic extract of *Desmodium oojeinense* against Paracetamol induced Hepatotoxicity in rats. Ethanolic constitute showed important ($p < 0.05$) hepatoprotective action by lowering the serum levels of different biochemical parameters such as SGOT, SGPT, ALP, total Bilirubin and by increasing the levels of total protein, in the selected model. These biochemical observations were in turn confirmed by histopathological examinations of liver group and are comparable with the standard hepatoprotective drug Silymarin (100mg/kg bodyweight i.p.) which served as a positive control³⁷.

10.5 Analgesic and anti-inflammatory activity

Jayadevaiah et al investigated the analgesic and anti-inflammatory activities of ethanolic extract of *Desmodium oojeinense* (Roxb.) in experimental rats. Analgesic activity was evaluated using acetic acid induced writhing method, while anti-inflammatory activity was evaluated using carrageenan induced rat paw oedema model. Various doses of ethanolic extract of the plant (100, 200, 400 mg/kg body weight) were tested for its analgesic activity and anti-inflammatory activity and the results were compared with the standard drug aspirin and diclofenac sodium respectively. Results indicate that the ethanolic extract of the plant significantly inhibited writhing movements in analgesic activity and carrageenan induced hind paw oedema in anti-inflammatory activity in a dose dependent manner³⁸.

Sahu et al screened the ethanolic and aqueous extracts of the bark of *Ougeinia oojeinensis* for anti-inflammatory activity. The protection of hypotonicity induced HRBC membrane lysis was taken as the measure of anti-inflammatory activity. Both the parts showed a biphasic action on the membrane stabilization. Their actions are comparable to that of high quality drug diclofenac sodium. However their action decrease with time³⁹.

10.6 Wound healing activity

Gunasekaran *et al* evaluated the wound healing activity of aqueous and ethanol extracts of *Ougeinia oojeinensis* was using excision, incision and dead space wound models on albino rats, the doses selected were the ED₅₀ values as determined in the acute toxicity studies, administered orally. Among the two extracts, the maximum activity was recorded in the ethanol extract followed by aqueous extract. However when compared with the control both the extracts were found to possess significant wound healing promoting activity⁴⁰.

Sahu *et al* investigated the wound healing potency of ethanol and aqueous bark extracts of *O. oojeinensis*. Excision wound model was used to evaluate the wound healing activity of both the extracts on wistar rats. The rats were divided into four groups and each group has six rats. The extract was used in the form of gel (200 mg of extract incorporated with 100 gm of Carbopol 940 to get 0.2% w/w gel) daily once times, Initially the excisions of skin from rats, till the complete epithelialization. The healing of wound was assayed by the speed of wound contraction and period of epithelialization. Both the ethanol and aqueous bark extracts promote the wound healing action significantly, when compared with the control group of animals. Ethanolic extract have better wound healing capacity than the aqueous extract⁴¹.

10.7 Others

Kumar *et al* demonstrate the formation of various silver nanoparticles by the reduced aqueous silver metal ions during there exposure to the ethanolic extract of *Ougeinia oojeinensis*. The silver nanoparticles found were characterized by colour change in the reaction, UV-visible spectrum, and scanning electron microscopy. The parameters of absorption peak at 450-500 nm in UV-Vis spectrum confirmed the formation of the silver nanoparticles. The size of nanoparticles synthesized differ from 5 to 100nm. Membrane stabilizing activity was done by the hypotonic solution whic induce hemolysis. Ethanol extract showed 79.87% activity where as AgNPs showed mild membrane stabilizing action. The antioxidant action of AgNPs was investigated by the DPPH method. Here both ethanol and AgNPs showed mild antioxidant action. Antibacterial and antifungal activities were performed by the diffusion method⁴².

Bhat and Patel studied the nuclear behaviour in two tropical angiosperm species: *Ougeinia oojeinensis* and *Garuga pinnata*. The ray parenchyma cells are of prime importance in the wood for their physiological activities like synthesis, degradation and translocation. They play a major role during the heartwood formation, especially in the formation of phenolic compounds⁴³.

Wankhade and Mulani evaluated the preliminary phytochemical test on leaf and bark methanolic extract of *Ougeniao oojeinensis*. The results of the preliminary phytochemical studies confirms the presence of carbohydrate, saponin, starch, flavonoids, steroids, alkaloids, glycosides, terpenoids and proteins in the methanolic extracts of *Ougenia oojeinensis* bark and leaves. This study also

estimated the Rutin and Qurecetin present in the methanolic leaf and bark extract of the *Ougeinia oojeinensis* through HPTLC method. The solvent system used for quantification of the quercetin and the rutin was Toluene: Ethyl acetate: Formic acid (6: 4: 0.8 v/v/v). The maximum R_f values of quercetin and rutin were observed 0.51 and 0.04 respectively. HPTLC fingerprint analysis of leaf and bark extract of *Ougeinia oojeinennsis* can be used as a diagnostic tool for the correct identification of the plant⁴⁴.

Bala and Uniyal described a simple binary gradient HPLC method employing a Symmetry C18 column is for the analysis of genistein, ougeinin, homoferririn, 2,4,5,7-tetrahydroxy-6-methyl isoflavone and 2,4,8-trihydroxy-6- methoxy-7-methyl isoflavone present in heartwood extract of *Ougeinia dalbergioides*⁴⁵. The 50% ethanolic extract of *Ougeinia oojeinensis* stem bark showed antispasmodic action on isolated guinea-pig ileum and weak CNS-depressant effect in mice. The extract of the whole plant showed anti-inflammatory effect against carrageenin-induced paw oedema and analgesic effect in rats. The extract was devoid of diuretic, hypoglycaemic, antipyretic and anticoagulant activities. The ethanolic extract of the stembark and the whole plant showed hypotensive action in cat/dog¹⁶.

11 Conclusion

In the current review, we have made an endeavor to give the mophological, phytochemical, ethnopharmacological and pharmacological information on *O. oojeinensis*. The plant *O. oojeinensis* has an excellent potential against various ailments and have been experimentally and clinically utilized in both animals and man. A variety of extracts and chemical compounds of the plant have shown antioxidant, antibacterial, cytotoxic, anti-inflammatory and hypoglycaemic activities ect. A huge number of compounds have been remote from *O. oojeinensis* and shown to possess assorted biological properties. There is lack of management and conservation plan from the government side. Similarly, lack of awareness of importance regarding *O. oojeinensis* among rural villagers is leading towards the destruction of this valuable species. Due to the overexploitation of one of the critically endangered plants, there is require to focus on conservation, upgradation and sustainable utilization of this wonder plant.

12 Conflict of interest

The authors declare that no conflict of interest is associated with this work.

13 Author's contributions

AT, AP, SS, SK, UV and PM contributed for the preparation of manuscript. All authors approved paper for publication.

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