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Review Article

PHYTOCHEMICAL CONSTITUENTS AND PHARMACOLOGICAL ACTIVITIES OF *Kigelia africana AND Mansoa alliacea* - A COMPREHENSIVE REVIEW

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ABSTRACT

Context: The focus of the present review is to compile the different phytochemical constituents and pharmacological activities of bignoniaceous plants, namely *Kigelia africana* and *Mansoa alliacea*.

Objective: Medicinal plants are routinely used in clinical practice for the treatment of various diseases of human beings over thousands of years across the world. In rural areas of the developing countries, they are still used in practice due to the easy availability of the medication. The main objective of this work is to explore the phytochemical studies and biological activities of plants belonging to Bignoniaceae family.

Methods: The present study also discusses about the different phytochemical constituents of *K. africana* and *M. alliacea* that were isolated and characterized using various analytical methods. Different extracts of these plants were subjected to different *in vitro* anticancer, analgesic, antimicrobial, and antimalarial activities using earlier reported methods were also discussed.

Results: *K. africana* is commonly referred to as sausage or cucumber tree due to its huge sausage or cucumber-like fruit. These plants find application as traditional medicine for treating several ailments such as malignant tumor, ulcer, aging, and malaria among others. It is conjointly used for the treatment of reproductive organ infections, renal ailments, dizziness, epilepsy, sickle cell disease, depression, metabolism disorders, skin grievance, leprosy, impetigo, helminthic infections, athlete's foot, tumors, etc. These plant extracts have also been used as a cosmetic by enhancing the collagen action and thus exhibit antiaging properties.

Conclusion: The present study attempts to provide collective information on various phytochemical constituents and pharmacological actions of *K. africana* and *M. alliacea* belonging to Bignoniaceae. This review in its present form is believed to help the researchers to provide adequate information about the chemical constituents and biological uses of these plants.

Keywords: Bignoniaceae, *Kigelia africana*, *Mansoa alliacea*, Phytochemical studies, Pharmacological studies.

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INTRODUCTION

Nature has been the supply of several healthful agents within the type of the isolated compound from natural resources for more than thousands of years [1]. Around 80% of the population across the world depends only on indigenous medicines to protect themselves from various diseases. The family Bignoniaceae is characterized by the woody stem, opposite, compound leaves, and zygomorphic flowers and has been covered in some major floristic projects [2]. The family is comprised about 112 genera and 725 species which are usually seen in tropical and subtropical regions of the world. In India, the family is represented by 15 genera and 40 species [3]. *Mansoa alliacea* is a native plant to South America, exactly from the Amazonian basin and has been collected in Bolivia, Brazil, Caribbean islands, Colombia, and Ecuador.

Brief description

Kigelia is a genus of flowering plants within the family Bignoniaceae [4] that consists of just one species, that is, *Kigelia africana*, fruit grows up to 2 feet long and appears like sausage. *K. africana* is commonly referred as sausage or cucumber tree due to its huge sausage or cucumber-like fruit [5]. These trees grow up to a height of 10–15 m, leaves decussate or ternate, 20–50 cm long, leaflets 5–9, ovate-oblong to elliptic-ovate, acute or mucronate at apex, often oblique at base, entire flowers in very long drooping lax panicles as narrow, pendent racemes; calyx copular, 2 lipped, greenish, glabrous; corolla dark wine red, 5–10 cm long, throat wide; stamens 4; and fruits shortly beaked 25–30 cm long commonly called as sausage tree, flowering, and fruiting takes place in the month from March to August [6].

M. alliacea is a native plant to South America, exactly from the Amazonian basin and has been collected in Bolivia, Brazil, Caribbean islands, Colombia, and Ecuador [7]. It is an evergreen climbing shrub with semi-woody branches that allow attaching on larger trees, used as growing supports. The plant reaches 3 m tall and its leaves are bright green, slightly coriaceous, opposite and characterized by two ovate leaflets of about 15 cm long. Flowers have funnelform corolla up to 6–9 cm long, with campanulate calyx, 5–8 mm long [8]. They are violet colored and grow in terminal or auxiliary raceme inflorescences. Fruits are elongate capsules up to 25–35 cm long which contain transverse-oblong seeds characterized by broad wings. Leaves of *M. alliacea* are characterized by a pungent garlic-like smell when crushed [9]. The aim of this current review is to explore the different phytochemical and pharmacological research work that was carried out so far on the plants of *K. africana* and *M. alliacea* belonging to the family Bignoniaceae.

Traditional uses

Several parts of *K. africana* were traditionally used as medicine by rural people in African countries. In Malwi, the seeds were roasted

and consumed throughout the famine. Baked fruits were fermented to brew and cooked ones yielded a red-colored dye [10]. Many tribals used various parts of these plants for treating a broader range of skin ailments such as flora infections and boils among others. Boiling of the leaves was utilized for the treatment of infectious disease, worm infestation, postpartum hemorrhage, malaria, diabetes, pneumonia, and aching [11]. Zambezi valley women use these leaves for the removal of blemishes. In folk medicine, fruit extracts were used for the ulcer, purgative, and as galactogogue. Shona individuals used various parts of these plants (bark or root) as infusion or powder for the respiratory disorder used as an analgesic for dental problems and for its medulla spinalis pain-relieving property [12]. The unripe fruit was employed as an antihelminthic and for the treatment of hemorrhoids and rheumatism [13]. Bark powder is employed due to the remedy for venereal diseases [14]. *M. alliacea* has also got several folklore uses and was used by various ethnic people for different diseases. In Brazil, the leaf extract was used traditionally for treating rheumatoid arthritis, dermal infections, and body cleaning purpose [15]. In South America, people used this plant extract traditionally for analgesic, antiarthritic, anti-inflammatory, antipyretic, antirheumatic, colds, constipation, nausea, pneumonia and respiratory disorders, purgative, and vermifuge [16]. However, all of these are only folklore uses, none of these has not been reported scientifically. Thus, the purpose of this review is to help the future researchers to study the biological effects using scientific models and validate the folklore usage of these plants.

Phytochemical studies

K. africana

From the phytochemical review of *K. africana* was found to have numerous secondary metabolites such as iridoids, flavonoids, and naphthoquinones, pinnatal and isopinnatal were found in root bark extract. 7-hydroxy viteoid-II, 7-hydroxy eucommic acid, 7-hydroxy-10-deoxyeucommiol, and 10-deoxyeucommiol along with few iridoids were isolated [17]. Fruit extract was found to have 6-*p*-coumaroyl-sucrose along with known phenylpropanoid and phenylethanoid derivatives [18]. From the heartwood, a major constituent known as kigelin was isolated by Govindachari *et al.* [19]. Stigmasterol and lapachol were separated from the basis extract of *K. africana* plant. Kigelin, β-sitosterol, 3-dimethyl kigelin, and ferulic acid were separated from the bark, few quinines, and new aromatic monoterpenes were also separated from the basis bark by Joshi *et al.*[20]. Verminoside and minecoside were the two iridoids isolated from stem bark using butanol as mobile phase.

M. alliacea

Essential oils were isolated from the leaves of *M. alliacea* and found to possess chemical groups such as alkyl trisulfide, disulfide, alkyl characid sulfite, 3-vinyl-1,2-dithi-4-ene, and diisoamyl disulfide [21]. The petroleum ether extract of *M. alliacea* leaves was found to have n-alkanes C_{25}-C_{35}, n-alkanols, 24-ethylcholest-7ene-3 β-ol, 19-hydroxyhexatriacontan-18-one, 32-hydroxyhexatriacontan-4-one, 34-hydroxy-8-methylheptatriacontan-5-one, pentatriacont-1-en-17-ol, β-sitosterol, stigmasterol [22], etc. A methanolic extract obtained from flowers of *M. alliacea* was found to own allicin, β-amyrin, apigenin, apigenin-7-glucoside, apigenin-7-glucuronide scutellarein-7-glucuronide, apigenin-7-glucuronyl glucuronide, apigenin-7-O-methyl glucuronide, cyaniding-3-rutinoside, ursolic acid, and luteolin [23]. Essential oils obtained from flowers were found to have diallyl disulfide, diallyl tetrasulfide, diallyl trisulfide, and 1-octen-3-ol [24]. Benzaldehyde, benzyl thiol, and dibenzyl disulfide are the inflorescences found in flower extract of *M. alliacea* [25]. 9-Methoxy-α-lapachone and 4-hydroxy-9-methoxy-laphachone were separated from bark of *M. alliacea* using methylene chloride and methyl alcohol as mobile phases [26]. p-Coumaric acid and resveratrol, and betulinic acid were isolated from the ether extract and binary compound infusion of entire stuff of *M. alliacea* [27].

Pharmacological studies

Anticancer activity

Crude chloride extracts of fruits and bark of *K. africana* showed profound cytotoxic action on *in vitro* cultured melanoma cells; an isopinnatal isolated compound from the bark of *K. africana* extract showed cytotoxic action on melanoma cells, whereas β-sitosterol was found to be inactive when compared with isopinnatal toward melanoma cells [28]. Considerable *in vitro* cytotoxicity was found by the iridoid-related compounds - norviburtinal and naphthoquinone, which were isolated from the fruit and bark extracts of *K. africana* [29]. Lapachol a compound isolated from *Kigelia* was found to very effective in solar skin disease, carcinoma, and Kaposi sarcoma (an HIV-related skin ailment) [30]. The antitumor activity of Bignoniaceae could be due to its naphthoquinones, and hence, lapachol has been considered a candidate for clinical use. Similarly the alcoholic and dichloromethane extracts of the roots of K. pinnata, another bignoniaceous plant had shown promising anticancer activity against melanoma and renal cell carcinoma (Caki-2 cell line) [31]. ϒ-sitosterol isolated from the extract of *K. africana* is known to contribute for the cytotoxic action which is compared with lapachol as the reference drug [32]. Seed oil isolated from *K. africana* has shown significant antiproliferative action on human embryonic kidney cells (HEK-293). *M. alliacea* leaf extract exhibited T3-HA cancer cells at low concentrations and cytotoxic action was found at higher concentrations [33].

Analgesic activity

Ethanolic extract of the stem bark of *K. africana* was evaluated for carboxylic acid acid-induced wriggly mouse model; it absolutely was conjointly tested in hot plate time interval and anti-inflammatory property in mice and guinea pigs. The probable mechanism could be due to the inhibition of prostaglandins synthesis at the dose of 500 mg/kg body weight [34]. Supercritical carbon dioxide extracts of *Kigelia* have shown potent anti-inflammatory action when compared with indomethacin and by inhibition of cyclooxygenase-2 against human neutrophils [35]. *M. alliacea* root and stem extracts have shown anti-inflammatory activities by inhibiting prostaglandin synthesis [36].

Antimalarial activity

Four naphthoquinones were isolated from the basis bark of plant and tested against *Plasmodium falciparum* strains which are sensitive to antimalarial drug (T9-96) and resistant to chloroquine. K1 the toxicity studies were carried out using computer memory unit cells. Lapachol and other components having antimalarial property was extracted from the roots and they have shown notable effect against malaria caused by resistant strains of P. falciparum [37]. The whole plant extract of *M. alliacea* was screened for antiplasmodial activity using dose of 500 mg/kg body weight and a notable action was observed [38].

Action on central nervous system

Ethanolic extract of the stem bark of *K. africana* was extracted using ethanol and was shown to be effective for the treatment of giddiness, drowsiness, and sedation. The stimulant activity of the central nervous system was carried out using mice victimization. The muscle coordination activity was studied using sleeping time induced using barbiturates and rotarod test [39]. The study was carried out using caffeine and diazepam at a dose of 400 mg/kg body weight which showed improved stimulant activities. The extract did not produce any sedative action on animals throughout entire period and they were found to retain their balance on the rotarod activity.

Antimicrobial activity

Isolated compounds from the *K. africana* from fruits and roots are believed to have antibacterial and antifungal activity. Isolated compounds such as phenylpropanoids, ferulic acid, and *p*-coumaric acid were screened against *Staphylococcus aureus*, *Bacillus* sp., eubacterial organisms, *Aspergillus niger*, *Candida* sp., and exhibited important antimicrobial action toward these organisms [40]. Steroids and flavonoids were found to be hygroscopic in nature and exhibited

significant antifungal action [41]. The chemical investigation revealed that iridoids present in the stem bark of *K. africana* had exhibited potent antimicrobial action against *Bacillus subtilis*, *Escherichia coli*, and *Monilia albicans* among others. The highest zone of inhibition was exhibited by alcoholic extracts than acetonitrile and methylene chloride extracts. Among all the organisms, *Pseudomonas aeruginosa* and *S. aureus* were inhibited by *K. africana* extracts [42]. *M. alliacea* leaf extract was tested against some of the fungal strains of *Alternaria brassicae*, *Colletotrichum capsici*, *Curvularia lunata, Alternaria alternata*, *Alternaria brassicicola*, *Alternaria carthami*, *Fusarium oxysporum*, and *Fusarium udum* and the extracts showed remarkable antifungal activities [43].

Diuretic action

The diuretic activity (dose 250 and 500 mg/kg body weight) was tested on male anomaly rats [44]. Notable diuretic action was exhibited by the *K. africana* extracts by increasing the water volume.

Miscellaneous activities

Molluscicidal activity was tested on adult snail *Biomphalaria glabrata* using the isolated compound of lapachol and isolapachol from *K. africana* by Kela *et al.* [45]. Ethanol extract of *Kigelia* showed promising inhibitor activity. The antidiabetic action was also screened by Kela *et al.* [45]. Biocide activity against *Hypsipyla grandella* and anopheles was screened using leaf extract of *M. alliacea*. The cholesterol-lowering effect was reported in dried flower extracts of *M. alliacea*. The decoction made from the leaves of *M. alliacea* was found to be effective against cough, nausea, and constipation [22]. Allicin was the compound isolated from *M. alliacea* and was found to have very good hydroxyl radical scavenging activity and was also found to exhibit antimicrobial action by affecting the RNA synthesis of microorganisms [46].

K. africana fruit extract is also known strengthen the collagen fibers of the breast [47]. Cream which was prepared from the fruit extract was found to be effective against sunspots known as solar keratosis. From the fruit extracts, shampoos were prepared for treating scalp related infections like psoriasis [48]. The cream prepared from fruit extract also helps in the tightening of the skin surrounding the eyes. The fruit pulp is found to be used as nutraceutical and dietary/herbal supplement, especially in skin tightening active agent [49].

CONCLUSION

The present review discussed about the phytochemical constituents and pharmacological activities of *K. africana* and *M. alliacea* belonging to the Bignoniaceae family. *K. africana* is an interesting plant that was widely used in indigenous system of medicine and is thus helpful beyond its original geographical range. The research work carried on these plants reveals that further pharmacological investigation is warranted to prove the folklore usage in a scientific method, as *K. africana* is known for iridoids which get accumulated in roots and flowers; hence, there is a need for the isolation and quantification of these chemicals for toxicological evaluations. It also shows that *M. alliacea* have been partially investigated and the findings presented in the current review make way to further explore folklore uses in a more scientific manner.

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AUTHORS' CONTRIBUTION

The authors SV and GS had contributed equally toward the collection of literature and preparation of the manuscript.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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