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Original Article

Green Gold- Exploring Therapeutic Importance of Murraya Koenigii- A Review

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ABSTRACT

Murraya koenigii, commonly known as curry leaf, is a medicinal plant widely used in traditional Indian medicine and cuisine. It belongs to the Rutaceae family and is native to tropical regions of Asia, with extensive cultivation throughout India. The plant is recognized for its aromatic properties and a broad spectrum of health benefits, attributed to its rich phytochemical profile. Key bioactive compounds include alkaloids [e.g., mahanimbine], flavonoids [e.g., quercetin], phenolics [e.g., gallic acid], essential oils, and vitamins A, C, and E. These constituents contribute to its antioxidant, anti-inflammatory, antimicrobial, and anti-diabetic activities. Traditionally, curry leaves have been used to promote digestion, enhance hair health, and manage metabolic disorders. In recent years, scientific advancements have led to the exploration of Murraya koenigii in various novel drug delivery systems, including nanoparticle formulations and phytosomes, enhancing its therapeutic efficacy and stability. This growing interest underscores its potential role in modern pharmacology as a natural, multi-functional remedy. The present review highlights the plant's phytochemical constituents, therapeutic applications, and recent formulation developments, reflecting its value in both traditional and contemporary medicinal systems.

Keywords: Murraya koenigii, Mahanimbine, Curry leaf, Silvernanoparticles, Anti-inflammatory, Phytosomes. Herbs, Dosage forms, etc

INTRODUCTION

Traditional systems of medicine have long depended on plants as a primary source of treatment for various health concerns. These plants contain numerous naturally occurring compounds, collectively referred to as phytoconstituents, which are responsible for their therapeutic effects. The World Health Organization reports that around 80% of the global population relies on traditional remedies for their basic healthcare needs. One such medicinally important plant is *Murraya koenigii*, commonly known as the curry leaf or *kari patta* in several Indian languages. This plant, belonging to the Rutaceae family, is a small, aromatic tree or shrub that typically grows between 4 to 6 meters tall. It originates from tropical regions of Asia, particularly near the Himalayan foothills, and is now cultivated widely across India and in other tropical and subtropical areas. The therapeutic potential of *Murraya koenigii* is attributed to its rich composition of bioactive compounds. These include alkaloids such as mahanimbine, flavonoids like quercetin, phenolic compounds including gallic acid, essential oils such as caryophyllene, and vital vitamins like A, C, and E. These constituents contribute to the plant's known health-promoting properties, including antioxidant, anti-inflammatory, and anti-diabetic effects. In addition to its medicinal applications, curry leaves are a staple in South Asian cuisine and are believed to support various aspects of health such as digestion, hair maintenance, and metabolic regulation. More recently, scientific interest in *Murraya koenigii* has led to the development of innovative formulations, including nanoparticles, phytosome-based extracts, and polyherbal solid dosage forms, highlighting its growing potential in modern pharmaceutical sciences.

1.1 History and Origin of Curry Leaves

The Curry leaf is very integral to the culinary world of South India. Evidence for its usage can be found in Tamil Literature, between the 1st and 4th century CE, and in Kannada Literature, a few centuries later. In

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

fact, the word 'curry' itself owes its origin to the Tamil word kari which is a term used for spicy sauces/gravies in the 16th century. Today it's frequently referred to as kari-pattha. It is interesting to note that, during the reign of Richard II in the late 1300s, there is evidence of English cooks preparing curry.[1] The curry leaf plant, scientifically known as Murraya Koenigii, is believed to have originated in the tropical regions of India and Sri Lanka. Archaeobotanical evidence suggests that the use of curry leaves in Indian cooking dates back to as early as the 6th century BCE, making it one of the oldest spices in the country's culinary history. [2].

Fig 1: Curry leaf plant [Murraya koenigii]

Fig 2: Curry leaves

1.2 Biodiversity Profile of Curry Leaves

Biological source: Curry leaves are obtained from the plant *Murraya koenigii [L.] Spreng*, belonging to the **family**: Rutaceae. It is a small, aromatic tree native to India and Sri Lanka.

Vernacular names:

Telugu: Karivepaku Hindi: Kari Patta Tamil: Karuveppilai	Kannada: Karibevu Malayalam: Kariveppila Marathi: Kadipatta	Gujarati: Mitho Limdo Bengali: Barsunga Patta Punjabi: Kari Patta

1.3 Taxonomical Classification:

Table 1: Taxonomical classification of murraya koenigii [3]

S.No	Kingdom	Plantae
1	Sub kingdom	Tracheobionta
2	Superdivision	Spermatophyta
3	Division	Magnoliophyta
4	Class	Magnoliospida
5	Subclass	Rosidae
6	Order	Sapindales
7	Family	Rutaceae
8	Genus	Murraya J. Koenig ex L.
9	Species	Murraya Koenigii L. Spreng

1.4 Botanical description:

MK is a medium size herb with height up to 6 m with 15–30 cm long leaves arranged in a bipinnate manner. MK plant has white coloured flowers with an average diameter 1.12 cm when it is fully bloomed. Fruits of this plant are wrinkled and when ripened turns to purplish black colour.[4] Leaflets alternate on rachis, 2.5 3.5 cm long ovate lanceolate with an oblique base. Margins irregularly creative and petioles 2 - 3 mm long. [5] The inflorescence is a panicle, cyme, or small raceme of flowers growing at the ends of branches or in the leaf axils; some flowers are solitary. The fragrant flowers have 4 or 5 sepals and white

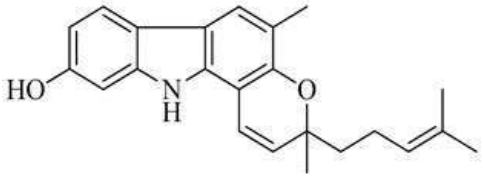
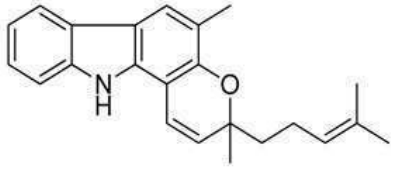
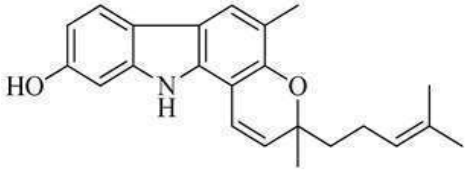
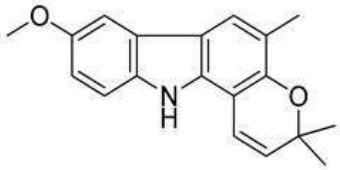
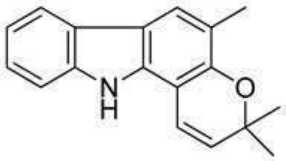
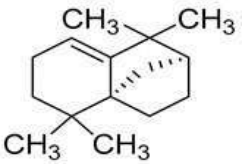
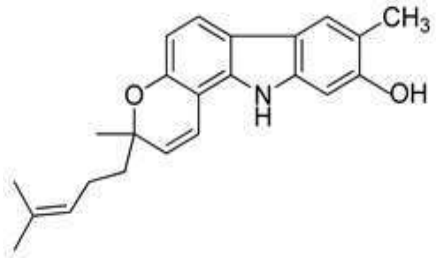
petals and up to 10 straight stamens. The fruit is a fleshy berry with pulp but without the juice vesicles present in some related fruits. It is up to 1.3 centimetres [0.51 in] long and orange, red, or black. [7]

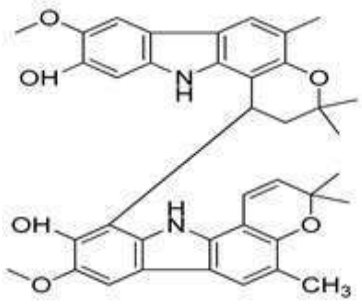
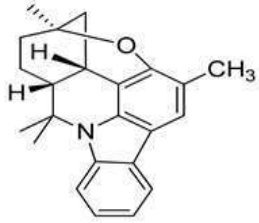
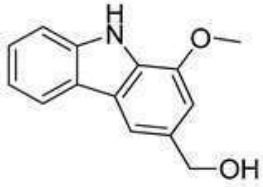
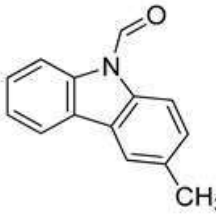
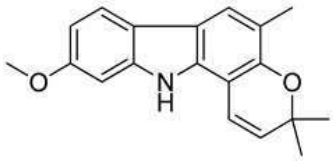
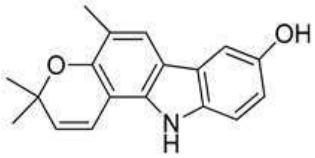
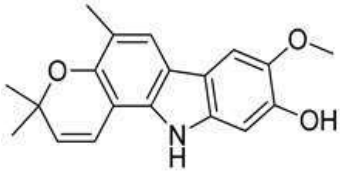
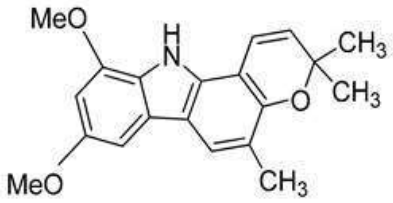
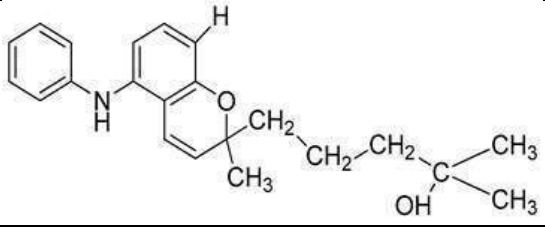
1.5 Natural habitat and Diversity:

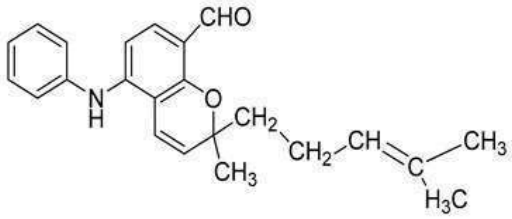
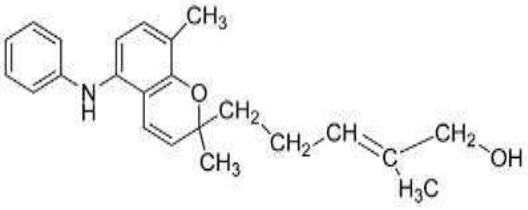
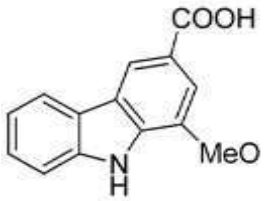
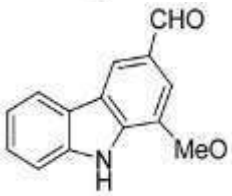
Curry leaf is also used in many of the Indian ayurvedic and unani prescriptions. The plant originated in the Tarai region of Uttar Pradesh, India, and at present it is cultivated in Burma, Ceylon, China, Australia and the Pacific Islands. The crop is usually propagated by seeds.[7] It is found abundantly in forests and waste lands in natural, wild and cultivated forms up to 1650 m altitude. In southern India, it is found in homestead gardens of every household. Based on several ethno-botanical reports and other floral distribution studies, the germplasm rich regions of curry leaf could be identified into six zones for future exploration and genetic improvement in India. [7].

1.6 Phytochemical Profile of Curry Leaves

Table 2: Chemical constituents of murraya koenigii. [8]

S. No.	Constituent	Constituent Structure	Activity
1	Mahanine		Cytotoxicity, anti-microbial, and anti-cancer
2	Mahanimbine		Cytotoxicity, anti-oxidant, anti-microbial, anti-diabetic, and hyperlipidemic
3	Isomahanine		Cytotoxicity, anti-oxidant, anti-microbial, anti-diabetic, and hyperlipidemic
4	koenimbine		Cytotoxicity and anti-diarrhea
5	Girinimbine		Anti-tumor
6	Isolongifolene		Anti-oxidant and neuroprotective
7	Pyrayafoline D		Anti-cancer and anti-bacterial

8	Murrayafoline		Cytotoxicity and anti-inflammatory
9	Murrayazoline		Cytotoxicity and anti-tumor
10	Koenoline		Cytotoxicity
11	9-formyl-3-methyl carbazole		Anti-oxidant
12	*O*-Methyl murrayamine		Anti-oxidant and neuroprotective
13	Koenine		Anti-oxidant
14	Koenigine		Anti-oxidant
15	Mukonicine		Anti-oxidant
16	Mahanimbinine		Anti-oxidant, anti-microbial, anti-diabetic, and hyperlipidemic

17	Murrayacinine		Anti-oxidant, anti-microbial, anti-diabetic, and hyperlipidemic
18	Mahanimboline		Cytotoxicity, anti-oxidant, anti-microbial, anti-diabetic, and hyperlipidemic
19	Mukoeic acid		Anti-oxidant
20	Murrayanine		Anti-oxidant

1.7 Phytochemical composition of Murraya koenigii leaf:

Table 3: Result of Phytochemical composition of Murraya koenigii leaf.[9]

Phytochemicals	Values [mg/100g]
Alkaloids	1.90 ± 0.01
Saponins	2.50 ± 0.01
Flavonoids	7.43 ± 0.03
Tannins	0.86 ± 0.02
Phenols	4.25 ± 0.04
Glycosides	0.11 ± 0.01

Values are triplicate determinations and represent in Mean ± STD

1.8 Proximate composition of Murraya koenigii leaf:

Table 4: Result of Proximate composition of Murraya koenigii leaf.[9]

Proximate compounds	Values [%]
Moisture content	23.4 ± 0.10
Protein	8.38 ± 0.02
Carbohydrate	39.44 ± 0.04
Fats	6.48 ± 0.22
Ash content	15.60 ± 0.21
Crude fibre	6.30 ± 0.05

#$Values are triplicate determinations and represent in Mean ± STD

2. Pharmacological Activites:

Antidiabetic Activity: Alkaloids present in the leaves of M. koenigii have inhibitory effects on the aldose reductase enzyme, and other enzyme systems for extending anti-diabetic effects. M. koenigii was tested for the glucosidase inhibitory property and was found to inhibit glycosidase. Alpha-glucosidase inhibitors are widely used in the treatment of patients with type 2 diabetes. [10] The anti-diabetic activity of Mahanimbine was performed on the streptrozotocin induced wistar rats by using pure compound at a dose of 50 mg/kg and 100 mg/kg. The possible mechanism by which the mahanimbine decreases blood sugar level may be by potentiating of insulin effect either by increasing the pancreatic secretion of insulin from beta cells of islets of langerhans or by increasing the peripheral glucose uptake. Mahanimbine showed appreciable alpha amylase inhibitory effect as compared with acarbose. [11] Antimicrobial Activity: Benzoisofuranone derivatives along with six known carbazole alkaloids and three known steroids were isolated from stem bark of M. Koenigii. These compounds are found to be effective in range 3.13 - 100 µg/ml concentration. Literature survey revealed that methanolic extract of 21 plant species were screened for in vitro antibacterial activity against multi resistant bacterial isolates including Gram positive and Gram-negative strains. Staphylococcus epidermidis was significantly inhibited by M. koenigii.

Phagocytic activity: The methanol extract of M. koenigii leaves was evaluated on human oral and cell mediated immune response to ovalbumin, phagocytic activity by carbon clearance test, nitric oxide NO release from murine peritoneal macrophages and cyclophosphamide induced myclosuppression. Phagocytic nature of macrophages was increased by the increase in production of Nitrite. Extract showed significant increase in NO production from peritoneal macrophage at 416 µg/ml and 834 µg/ml with 24% and 56% respectively. This activity was evidenced by increase in Phagocytic index in carbon clearance test.[11]

Hepatoprotective Activity: The hydroalcholic extract of Murraya Koeinigii showed a dose dependent hepatoprotective activity against carbon tetrachloride induced liver damage in rats. The hepatoprotective activity of hydroalcholic extract of Murraya Koeinigii was also supported by the histopathological examinations of rat livers treated with CCl4 and HAMK. The hepatoprotective activity of many plants has been attributed to their high phenolic contents. The phenolic compounds of HAMK may have attributed towards the hepatoprotective activity of extract because other studies have demonstrated that various phenolic compounds contain significant hepatoprotective activity. [12]

Anti-Inflammatory: Three solvents that were used for extraction of Murraya koenigii leaves were petroleum ether, chloroform and ethanol. The dose of 250mg/kg, which is equivalent to one-tenth of the lethal dose [LD50] of 2500mg/kg, was delivered to the rats by oral route. The anti-inflammatory activity of the ethanolic extract was superior among the three extracts as indicated by the significant increase of the paw edema induced by carrageenan in Wistar albino rats.[10]

Antiulcer Activity: Crude aqueous extract of leaves showed anti-ulcer activity which was evaluated by using models of acute gastric lesions induced by ethanol induced, aspirin induced, cold restrain stress and pylorus ligation in rats. Animals were pretreated with doses of 200 mg/kg and 400 mg/kg of aqueous extract which showed efficient reduction in lesion index, total affected area and percentage of lesion in comparison with control group in the ethanol induced, aspirin induced, cold restrain stress induced ulcer and pylorus ligation models. Extracts were effective in gastric ulceration and suggested as protective as ranitidine.[11]

Fig 3: Pharmacological activities of MK

Anti-oxidant activity: Hydro alcoholic extract of Murraya koenigii is rich in flavonoids and phenolics and have greater ntioxidant capacity compared to other two extract [aqueous and methanol extracts]. A significant correlation was obtained between antioxidant activity and phenolic content indicating that phenolic compounds contribute significantly to antioxidant activity of the investigated plant. [13]

Anti-tumour activity: Evidence for anticancer activity of MK has been gleaned from rodent cancer cell lines as well as different *in vivo* cancer models. In an early study, histopathological evidence showed the decreasing number of neoplasms in colon upon treatment with MK extract. A significant decrease in tumour volume was observed in Dalton's ascetic lymphoma model of a group of Swiss albino mice upon treatment with MK extract.[14]

Anti-fungal activity: The ethanol extract of curry leaves exhibited antifungal efficacy against the growth of fungus Pityrosporum ovale and Candida albicans.[15]. The study tested the antifugal activity of aqueous and organic extract and their respective dilutions from a medicinal plant [Murraya koenigii] against four fungi species namely; *Aspergillus niger*, *Penicillium camemberti, Candida albicans, Penicillium funiculosum.* According to the results obtained from the extraction of ethanol, distilled water and hot water, ethanol has a greater inhibitory value.[16]

Anti-Diarrheal activity: The bioassay guided fractionation of the n-hexane extract of the seeds of M. koenigii resulted in the isolation of three pure compounds of bioactive carbazole alkaloids, kurryam, koenimbine and koenine. Of the three compounds kurryam and koenimbine exhibited significant inhibitory activity against castor oil-induced diarrhoea and PGE2-induced enter pooling in rats. The compounds also produced a significant reduction in gastro-intestinal motility in the charcoal meal test in Wister rats.[11]

Wound Healing effect: Male albino rates were used to check the wound healing activity by screening with ethanolic extract of leaves of M. Koenigii. In the excision, wound healing model reveals that three groups which were taken for wound healing activity showed a decrease in wound area from day to day. Incision model showed a significant increase in tensile strength of the 12-day old wound due to

treatment with M. koenigii. Thus, the leaves of Murraya koenigii were proved to possess significant wound healing capacity.[11]

Analgesic and antinociceptive activity: The methanolic extract of leaves showed analgesic effect in hot plate model and formalin induced paw licking response in mice. The activity might be linked to the processes involved in the prevention of sensitization of nociceptors, down regulation of the sensitized nociceptors or blockade of the nociceptors at peripheral and central levels. Methanol extracts were taken at different concentrations, viz. 100mg/ml, 200mg/ml and 400 mg/ml. Among these 400 mg/ml showed prolific results.[11]

Neuroprotective Effect: The neuroprotective effect of nerolidol [NRD], a sesquiterpene alcohol, was discovered in the essential oil of *M. koenigii* leaves from the studies with a rotenone-induced model of PD. NRD supplementation considerably improved the levels of oxidative stress markers [SOD, CAT, GSH, and MDA]. NRD also inhibited the release of pro-inflammatory cytokines and inflammatory mediators. Moreover, NRD treatment prevented the rotenone-induced activation of glial cells and the loss of dopaminergic neurons and nerve Fibers, thus mitigating rotenone-induced dopaminergic neurodegeneration. [17].

1. Recent Developments of Murraya Koenigii

3.1 CdS nanoparticles using Murraya Koenigii leaf extract:

Cadmium sulphide is traditionally known as yellow pigment called ‘aurora yellow’. The search of cadmium for industrial applications revealed that it occurs as sulphide in grenockite mineral, a companion to sphalerite [ZnS]. CdS exhibits many remarkable characteristics including good thermal, mechanical and size-dependant optical properties, which has potential applications in lasers, light-emitting diodes and optical devices.[18] CdS nanoparticle shows size dependent properties due to its very high surface to volume ratio and quantum confinement at nanoscale. CdS nanoparticles also have high photosensitivity that makes them suitable for optoelectronic devices and a number of biological applications.[18] The synthesis of CdS nanoparticles is carried out by green method using Murraya Koenigii leaf extract which act as a capping agent or stabilizing agent to reduce cadmium sulfide to nanosize particles. A simple, economic, green and ecofriendly route of cadmium sulphide nanoparticle synthesis has been developed by using as Murraya Koenigii capping agents. This method is eco-friendly for commercial scale production as it does not involve the use of hazardous and toxic capping agents. Further, concentration of capping agent has significantly affect and can be seen in crystallite size and a blue shift was seen in λmax.[18] Further, CdS nanoparticles has potent antibacterial activity against all tested bacterial strains and hence, it is valuable in the field of medicine and drug development.[18].

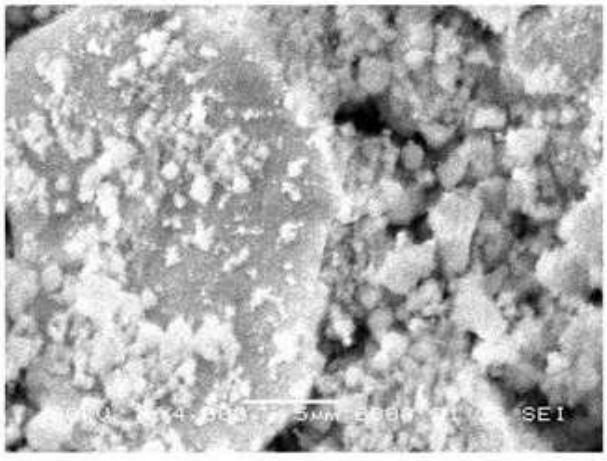


Fig 4: SEM image of Murraya Koenigii cappped CdS nanoparticles. [18]

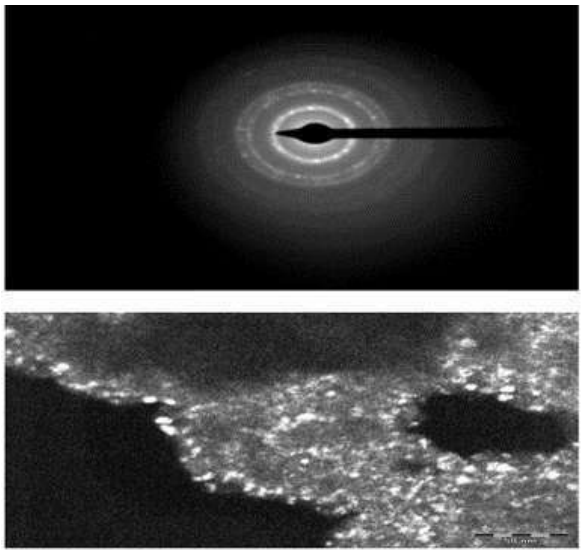


Fig 5: TEM image of Murraya Koenigii cappped CdS nanoparticles.[18]

3.2 Murraya koenigii Extract Loaded Phytosomes:

Phytosomes is a novel drug delivery system introduced by Indena. It incorporates standardised herbal extracts into suitable phospholipids in various ratios to provide better release characteristics and absorption to enhance bioavailability. The preparation of phytosomes was carried out using Antisolvent precipitation technique. Then the prepared phytosomes were optimised using factorial design. Factorial design offers a measurably precise methodology for the design, development and optimisation of phytosomes. The result obtained from animal studies shows the potential of phytosomal formulation for antidiabetic as well as hypolipidemic uses. Moreover, the results demonstrated that the phytosome based drug delivery approach could be a valuable tool to improve the therapeutic efficacy of phytochemicals by improving their absorption, and bioavailability via altering their physicochemical and release properties.[19].

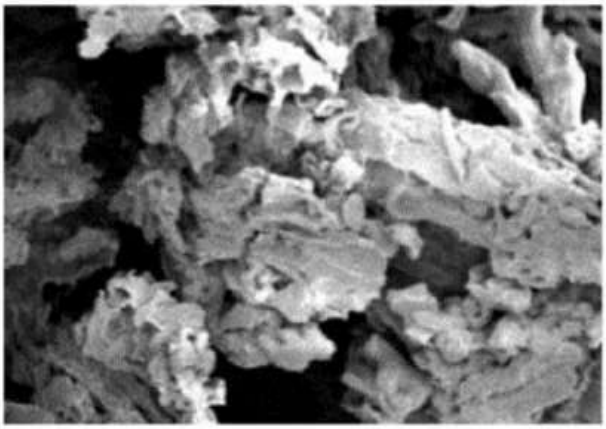


Fig 6: SEM of optimized Formulation of Murraya koenigii.[19]

3.3 Polyherbal solid dosage forms:

A polyherbal solid dosage form refers to a pharmaceutical formulation that combines extracts or powders from two or more medicinal plants into a single solid preparation, such as tablets, capsules, or granules. These polyherbal solid dosageforms are standardized as per WHO guidelines of quality standardization. They are then evaluated for Antioxidant parameters [DPPH and ABTS assays] and Antimicrobial activity. Murraya koenigii is used in various polyherbal solid dosage forms. It is used in combination with other herbs such as Zingiber officinale, Syzygium cumini, Phyllanthus emblica, Moringa oleifera, Azadirachta indica, Citrous limon for systemic diseases. The polyherbal solid, Dosage

form was formulated by filling the polyherbal powder mixture into the hard gelatin capsules, standardized as per WHO guidelines of quality standardization. Pharmaceutical parameters i.e. weight variation; moisture analysis and drug content are within I.P limit. Dissolution studies reveal that the release of maximum drugs [91%] at 120 minutes. The DPPH assay and ABTS assay activity of the polyherbal extract is found to be close to the standard drugs. Antimicrobial activity of polyherbal extract showed zone of inhibition 34mm for E-coli and 12 mm for Aspergillus Niger. The polyherbal drugs are less effective against rest of the microorganisms.[20]

Fig 7: Curry leaves incorporated Polyherbal solid dosage form

3.4 Silver Nanoparticles Using Murraya Koenigii [Curry Leaf]:

Silver nanoparticles [AgNPs] have become the focus of much research interest due to their wide variety of applications. Their ability to alter the physical, optical and the electronic properties of compounds have found applications in various fields including electronic devices, chemical/biological sensing, and surface enhanced Raman spectroscopy. In contrast, a promising usage of AgNPs as antimicrobial agent is well known and has already found applications in antimicrobial paint coatings, textiles, water treatment, medical devices, and HIV prevention as well as treatment.[21].

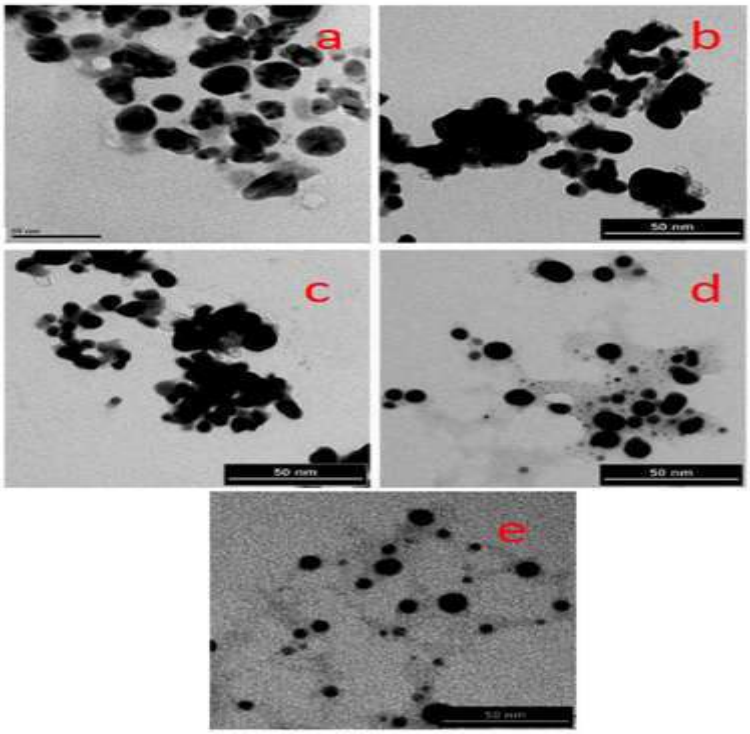


Fig 8: TEM images of the biosynthesized silver nanoparticles.[21]

3.5 Murraya koenigii Anti-acne gel:

Acne vulgaris is a common skin disorder, especially among adolescents, affecting areas rich in sebaceous glands such as the face, chest, and back. It is primarily associated with the bacterium Cutibacterium acnes, which contributes to inflammation by breaking down sebum into fatty acids, leading to clogged pores and pustule formation. While antibiotics are frequently used, rising antibiotic resistance has encouraged exploration of natural, plant-based alternatives. One notable recent development involves the use of Murraya koenigii, commonly known as curry leaves, in topical anti-acne formulations. Traditionally valued in Indian medicine, Murraya koenigii possesses antimicrobial, anti-inflammatory, and antioxidant properties due to its rich content of carbazole alkaloids, flavonoids, and essential oils. These bioactive compounds have shown promising activity against acne-causing bacteria. Recent research has led to the formulation of anti-acne gels containing extracts of Murraya koenigii. These gels are being studied for their potential to reduce acne lesions without the side effects associated with synthetic antibiotics. The incorporation of Murraya koenigii extract into modern dermatological products reflects a growing trend in herbal-based skin care and offers a promising, sustainable alternative in acne management. [22]

Fig 8: Curry leaves incorporated Anti-acne gel.

3.6 Murraya koenigii-Based Herbal Hair Serum:

The application of Murraya koenigii [curry leaves] in modern hair care has seen promising developments, particularly in the formulation of herbal hair serums. These lightweight, non-greasy serums serve as an innovative alternative to traditional hair oils, offering benefits like frizz control, reduced breakage, and improved hair texture. Recent studies and product innovations have focused on the bioactive compounds in curry leaves, including alkaloids, flavonoids, and essential oils, which promote hair growth, strengthen follicles, and delay greying. Their antioxidant and antimicrobial properties also support scalp health, making them valuable in both therapeutic and cosmetic applications. A novel serum formulation was developed using an ethanolic extract of shade-dried curry leaves. The extract was combined with nutrient-rich ingredients such as almond oil and vitamin E, enhancing moisture retention and scalp nourishment. The formulation process involved maceration, filtration, and careful blending of oil and aqueous phases under controlled conditions. The result was a stable, easy-to-apply herbal serum. This development reflects the growing trend of integrating traditional herbal knowledge with modern cosmetic science. The use of Murraya koenigii in serum form represents a recent advancement in natural hair care, aligning with the demand for effective, safe, and plant-based products in the personal care industry.[23]

Fig 9: Curry leaves incorporated hair serum.

CONCLUSION:

Murraya koenigii, a well-known traditional herb, stands out as an abundant natural source of bioactive compounds with significant therapeutic and industrial potential. Throughout this review, we have explored its rich historical background, diverse chemical profile, botanical characteristics, and broad range of pharmacological properties, all of which underscore its enduring relevance in traditional healing practices. Importantly, the plant's nutritional and medicinal significance is continually being reinforced by modern scientific studies, which confirm its role as a potent antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, antidiabetic, and lipid-lowering agent. More recently, advances in nanotechnology and formulation research have opened new avenues for the practical use of M. koenigii. Innovative strategies such as green synthesis of nanoparticles, phytosomes-based delivery systems, and its incorporation into functional foods and topical products — including anti-acne gels, herbal hair serums, and polyherbal solid dosage forms — are demonstrating the versatility and scalability of this plant in contemporary healthcare. These novel formulations not only enhance the bioavailability and stability of its phytochemicals but also offer safer, eco-friendly alternatives to synthetic agents. Overall, the future prospects for M. koenigii look promising, with the potential to inspire next-generation innovations that bridge traditional knowledge with modern medicine for improved human health and well-being

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