Annals of Phytomedicine 12(2): 275-283, 2023

DOI: http://dx.doi.org/10.54085/ap.2023.12.2.33

Annals of Phytomedicine: An International Journal
http://www.ukaazpublications.com/publications/index.php

Print ISSN : 2278-9839 Online ISSN : 2393-9885

Review Article : Open Access

Pharmacognosy, phytochemistry and pharmacological profile of *Gynandropsis gynandra* L.: A review

D. Santhosha◆ **and S. Dinesh Mohan**

Vishnu Institute of Pharmaceutical Education and Research, Narsapur, Medak-502 313, Telangana, India

Article Info

Article history
Received 7 October 2023
Revised 25 November 2023
Accepted 26 November 2023
Published Online 30 December 2023

Keywords
Spider wisp
Phytoconstituents
Microscopy
Glycosides
Tannins
Pharmacology

Abstract

Gynandropsis gynandra L., also called as *Cleome gynandra* and commonly referred to as Spider wisp, is an annual herb that thrives abundantly across India and holds a prominent position in the realm of healthcare. This unassuming plant, boasts a diverse array of phytoconstituents, including cardiac glycosides, carotenoids, flavonoids, saponin, cyanogenic glycosides, triterpenes, sugars, and tannins, which collectively endow it with formidable medicinal properties, making it a versatile natural remedy. Traditional healing practices have long recognized the utility of Spider wisp. It finds application in addressing a wide spectrum of health concerns, including osteoarthritis management, where it proves invaluable. Moreover, the herb's paste serves as an effective agent for the cleansing and healing of infected wounds. Spider wisp also earns its place as a cardio tonic, contributing to heart health. Within the framework of Ayurveda, this herb has a multifaceted role in treating ailments such as abdominal tumors, kidney stones, worm infestations, itching, and ear disorders. The focus of this review is to illuminate the comprehensive attributes of Spider wisp, with particular emphasis on its microscopic characteristics, phytochemical composition, and the extensive pharmacological research conducted to unlock its therapeutic potential. In India's rich landscape of traditional and modern healthcare, Spider wisp continues to stand as a valuable ally in promoting well-being.

1. Introduction

There is a growing demand of medicinal plants for pharmaceuticals, phytochemicals, nutraceuticals, cosmetics and other relevant products (Rekha, 2021). Exploration of traditional medicine is an interesting and challenging task for the ethnobotanists (Santhosha and Ramesh 2022). This review throws light on one such plant, *G. gynandra*, an annual herb also called *C. gynandra,* with common name as Spider flower. It is about 250-600 mm height; multi-branched and after maturity turns woody. The stem is gummy with glandular hairs and leaves are compound with 3-5 leaflets. The leaf petiole is 20-50 mm long with hairs on it. The leaflets are present around the leaf stalk and tapered towards the base. Flowers are bisexual, bracteate, white or purple in color. The fruits are capsular in shape, sub-erect, 31-150 x 2.5-4.5 mm long. The seeds are brown in color with a circular shape, 1.5 mm in diameter size as shown in Figure 1 (Anbazhagi *et al*., 2009). Phytochemical analysis of the leaf powder showed the presence of some of the phytoconstituents which include cardiac glycosides, carotenoids, flavonoids, saponin, cyanogenic glycosides, triterpenes, sugars, tannins and so on (Anbazhagi *et al*., 2009).

Figure 1: Flower and plant of *G. gynandra*.

Corresponding author: Dr. D. Santhosha
Associate Professor, Department of Pharmacognosy, Vishnu Institute of Pharmaceutical Education and Research, Narsapur, Medak - 502 313, Telangana, India
E-mail: santhosha.d@viper.ac.in
Tel.: +91-8142596896

Traditional information possessed by rural ladies recommends that *C. gynandra* has many therapeutic uses. It improves digestive strength, acts as cardiac tonic, congenial for the heart. It improves taste, relieves anorexia. It is also good for the eyes. It is indicated in inflammation, skin problems, itching, pruritis, worm infections, toxic conditions, poisoning, ascites, enlargement of the abdomen, ear problems, diarrhea, and asthma. Seed is indicated in tumors of the abdomen, bloating, abdominal colic pain (Sastry, 2014). Leaf paste or seed paste is applied over joints to treat osteoarthritis. It is additionally used as paste over infected wounds for cleansing and healing purpose. In inflammatory swellings, its paste is applied so that pus is formed soon and wound healing process initiates. Its paste is employed in snake bite or scorpion bite. *C. gynandra* is employed in ayurveda for abdominal tumors, kidney stones, worm infestations, itching, and ear disorders. Along with this, there are also other plants used for effective treatment of kidney stones, out of which, *Bauhinia purpurea* L, *Celosia argentea* L, *Macrotyloma uniflorum* are important (Sushmitha *et al*., 2020). Leaves could also be smashed to form a preparation that is administered to cure diseases like scurvy. In many areas, leaves are cooked and stored in bitter milk for 2-3 days and used as a nutritive meal to boost visual sense, supply energy and combat malnutrition. The leaves and seeds are utilized in indigenous medicine in several countries. Sap from leaves is employed as pain reliever. Sap from young leaves is squeezed into ears, nostrils and eyes to help epilepsy and aching. Boiling or extract of leaves/roots is used to ease childbirth, treat redness, treat severe thread-worm infection, and relieve chest pains. Leaves are used in arthritis and have anti-inflammatory properties and also to treat headache, neuralgia, rheumatism and different localized pains. They are rubbed on the affected components of the body or applied as a poultice. In Taiwan, it is employed to treat infectious diseases, gonorrhoea, malaria, autoimmune disease. In India, it has been historically used as medicinal drug. It can also be consumed either in whole part or formulated in the form of Tulha tablets (Aarati *et al*., 2022) and Nanoemulsions (Ajay *et al*., 2023).

2. Microscopic structures

The transverse section of leaf shows a number of layers of epidermis followed by polygonal cells, a group of stone cells with reddish-brown colour with non-lignified walls; starch and crystals are absent. Upper epidermis is single layered. Multiseriate glandular trichomes are present on both surfaces. Mesophyll consists of palisade cells with spongy parenchyma. Vascular bundles are large, collateral and arc-shaped in primary veins, small and round in secondary veins. Xylem towards adaxial side, phloem on abaxial side, bundle sheath large, parenchymatous cells which are barrel shaped, bundles of tertiary veins sandwiched between mesophyll cells. Lower epidermis is single layered, thick walled; guard cells are large, thick walled, embedded to subsidiary cells with thick-cuticle, lamellar, forming very tiny outer ledges over guard cells (Anbazhagi *et al*., 2009) .

Epidermis in surface view: The costal epidermal cells are large axially oriented 5-10 times longer than broad, rectangular or rhomboidal in shape, straight and thick walled. Intercostal cells are large and differently shaped, thin walled. Three types of glandular hairs are reported in both costal and intercostal regions. Large shaggy glandular hairs sparsely distributed in intercostal region. Stomata distributed in costal and inter costal region, facing all directions, medium sized, sub-spherical or elliptoidal shapes. Three types of stomata are present. They are anomocytic, anisocytic and tetracytic, the last type is more abundantly found. These are common on both the epidermis. The epidermal cells on the adaxial sides are straite walled and abaxial epidermal cells are more undulated. The trichomes present along the margins of the veins are either uniseriate or multiseriate glandular hairs as shown in Figure 2 (Mishra *et al*., 2011).

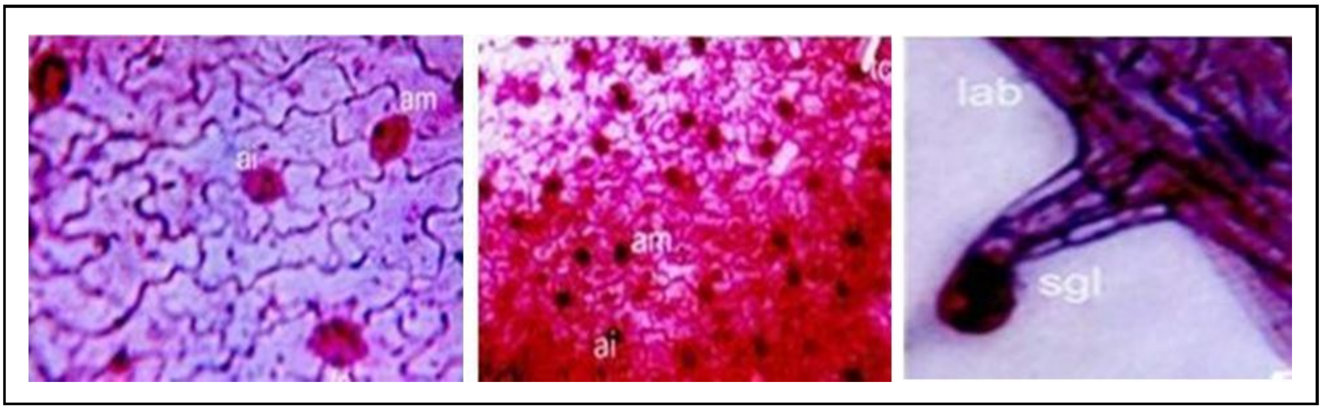

Figure 2: Microscopic characters of *G. gynandra*.

3. Phytochemical analysis

Phytochemical analysis of the leaf powder showed the presence of some of the phytoconstituents which include cardiac glycosides, carotenoids, flavonoids, saponin, cyanogenic glycosides, triterpenes, sugars, tannins, *etc*. Seed has shown the presence of following fatty acids like linoleic acid, palmitic acid, stearic acid, arachidic acid along with B-sitosterol, kaempferol, glucocibrine, glucoca, arine, glucobrassicin, luteolin and centauridin. The root is found to have two glyco-flavonones as narringenin-4-galactoside-1 and dihydrokaemferol-4f-galactoside-2. The aerial parts have shown the presence of a new glycoside-7, 3r-4-trihydroxyflavonone-5-0-a-L-rhamnopyranoside-3 along with a new glycoside-naringenin. In 1979, a unique di-terpene lactone cleomeolide-6 from *Cleome icosandra* and a new saponin named as stigma-5, 24-(28)-diene-3B-0-a-L-rhamnoside-7 was isolated. Similarly, p-amyrin, lupeol, and a new glycoside from the roots and coumarino lignoid from seeds are also identified. In 1984, isolation of kaempferol and luteolin-7-o-glucoside were reported (Anbazhagi et *al*., 2009; Sastry, 2014).

4. Pharmacological research on *G. gynandra*

Sharaf and Hamidi (1960) carried out preliminary phytochemical and pharmacological evaluation on the leaves of *G. gynandra*. It showed that they contain alkaloidal and resinous substances along with tannins and volatile oil. It may help in getting relief from arterial hypertension and constipation as it has been proved to lower blood pressure and stimulate the intestinal muscles.

Table 1: **Chemical constituents present in different parts of *G. gynandra***

S.No.	Plant part used	Chemical constituents found
1.	Leaf	Cardiac glycosides, carotenoids, flavonoids, saponin, cyanogenic glycosides, triterpenes, sugars, tannins
2.	Seed	Linoleic acid, palmitic acid, stearic acid, arachidic acid along with B-sitosterol, kaempferol, glucocibrine, glucoca, arine, glucobrassicin, luteolin, centauridin. Newly identified coumarino lignoid.
3.	Root	Glyco-flavonones as narringenin-4-galactoside-1 and dihydrokaemferol-4f-galactoside-2, p-amyrin, lupeol
4.	Aerial parts	New glycoside-7, 3r-4-trihydroxyflavonone-5-0-a-L- rhamnopyranoside-3 along with a new glycoside-naringenin

Lwande *et al*. (1999) studied repellent property of the volatile oil of the anti-tick shrub. The isolated constituents were tested against the livestock tick, *Rhipicephalus appendiculatus*. In a tick-climbing repellency assessing bioassay, the volatile oil of the plant showed a repellent effect greater than standard, N, N-diethyltoluamide. Carvacrol being the highest content followed by transphytol, linalool, trans-2-methylcyclopentanol and nerol, trans-geraniol, carvacrol, β-ionone, trans-geranyl acetone and nerolidol were identified as the most powerful repellent components against *R. appendiculatus*.

Ajaiyeoba (2000) performed phytochemical screening and antimicrobial studies of *G. gynandra* in combination with *C. coriaceae*. Leaf and stem extracts of *G. gynandra* and *B. coriaceae* were screened for phytoconstituents and for *in vitro* antibacterial and antifungal properties, respectively. The phytoconstituents found in both plants were alkaloids and glycosides (cyanogenetic, steroidal and anthaquinone). Hexane and methanolic extracts of both the plants were screened for antimicrobial property. At a dose of 200 mg/ml, the extracts exhibited different ranges of potential in tested bioassays. Out of the eight extracts tested, *B. coriaceae* stem hexane extract exhibited maximum activities in both assays in the agar cup method.

George *et al*. (2005) studied the effect of whole plant extract of *G. gynandra* on cancer cell lines. About six cancer cell growth inhibitors were isolated from the extract known as flavones and flavonols. The isolated flavonols suppressed the murine P388 lymphocytic leukemia cell line with ED_{50} values of 3.1, 9.3, 4.1, 0.27 and 2.9 µg/ml, respectively. All the isolated flavonoids showed protective activity against a group of six human cancer cell lines.

Sivanesan and Hazeena (2007) studied antioxidant activity the extract against lipid peroxidation. It was observed to decrease the rate of lipid peroxidation with the increase in non-enzymatic and enzymatic antioxidants. These have altered the readings that took place after administering aflatoxin B1 (AFB1). The result showed its chemopreventive efficacy by suppressing the rate of lipid peroxidation and altered the enzymatic and non-enzymatic antioxidants in male albino rats.

Latha *et al*. (2007) studied the effect of immunotherapy along with plant extract on asthma patients. The impact of immunotherapy with specific pollen *G. gynandra* on some of the parameters like skin test, symptoms score, drugs intake and total sIgE levels were determined in sixty human volunteers. The percentage of symptoms score and medicine was declined and total sIgE levels were not consistent after the course of immunotherapy. The decline may be due to impact of immunotherapy with *G. gynandra*.

Vanden and Venter (2006) studied about nutritional values of *C. gynandra*. Fresh and dried leaves are used in pureed foods. The leaves are cooked with other leafy vegetables because of bitter taste. Cooking the leaves may degrade vitamin C content by 81%, while drying reduces the vitamin content by 95%. Leaves may be used to cure diseases such as scurvy. In other regions, leaves are boiled and imbibed in sour milk for 2 days and consumed as a nutritious meal, which is supposed to improve eyesight, generate energy and combat malnutrition.

Borgio *et al*. (2008) studied antimycotic, antibacterial and phytochemical properties of leaves, roots, stems, seeds and seed pods of *G. pentaphylla*. They were extracted with methanol, acetone and water. Extracts were tested against two bacteria and also against three fungi. All the extracts analyzed phytochemically to determine various phytocontituents. Bacterial cultures of *E.coli* and *Staphylococcus aureus* were affected by the acetone extracts of all the 5 parts of *G. pentaphylla*. *Aspergillus niger, Aspergillus flavus* and *Metarhizium anisopliae* were affected by the methanol extracts of all the elements of *G. pentaphylla*. The active antimicrobial component is yet to be identified.

Nyalala and Grout (2007) experimented on companion planting of *C. gynandra* in beds of cut-flower roses which promisingly decreases red Spider mite infestation without any impact on productivity as well as quality of the flower. The extent of decline is directly proportional to the density of the *C. gynandra* plants. Greenhouse raised development may be of considerable in addition to other mite-control methods. The significant benefits of companion planting for farmers and sellers of roses are clear.

Jalalpure *et al*. (2007) studied anthelminthic activity of seed oils of polyherbs *G. gynandra, I. balsamina, C .paniculata, E. ribes and M. pruriens* against *Pheritima posthum*a. Three doses of each plant, in the form of oil were studied here, which involves the calculation of duration of paralysis and duration of death of the worm. All the oils showed promising anthelmintic activity, but *Embeliaribes* showed maximum activity. The standard used was piperazine citrate at a dose of 10 mg/ml.

Borgio *et al*. (2008) investigated toxicity effects of different parts of *G. pentaphylla* in benzene and ether. Fresh extracts were tested against six bacterium and four fungi using well diffusion technique. Extracts of different parts showed the presence of phytochemicals using both ether and benzene. Among the bacterial cultures, *Agrobacterium tumefaciens* was highly affected by both the extracts. It also exhibited the highest zone of inhibition for all extracts. Among the fungi, *Penicillium notatum* was highly affected by the benzene extracts of *G. pentaphylla* leaf extract.

Ghogare *et al*. (2009) carried out studies to validate antinociceptive activity of leaves of *G. gynandra* in the treatment of pain. The leaf extracts were screened for the activity using the eddys hot plate method and acetic acid-evoked writhing method in mice at a dose of

100 mg/ kg b.w intraperitonially. Ethanolic and aqueous extracts were found to be powerful in both the tests. The action was counteracted by Naloxone in the hot plate method indicating the role of opioid receptors in the action. Flavonoids and tannins were present increasing the probability of their role in the activity.

Uma *et al*. (2009) performed phytochemical screening and *in vitro* antimicrobial activity of *C. gynandra against* few bacterial and fungal. Different extracts were tested for the activity by disc diffusion method. The phytochemical screening has revealed the presence of various primary and secondary metabolites. The results exhibited powerful activity of methonolic extract compared to chloroform and aqueous extract showed negligible activity. None of the extracts possess antifungal activity.

Ogunmefun and Ajaiyeoba (2016) assessed antihelminthic activity of two plants; namely, *G. gynandra* and *B. coriacea* against *Fasciola gigantica*, *Pheritima pasthuma* and *Taenia solium*. Piperazine citrate solution was used as a reference standard and distilled water was used as the control.

Sambasiva *et al*. (2013) assessed liver protective activity of various extracts of *G. gynandra*. Three doses selected for the activity are 100, 200 and 400 mg/kg for their potency against CCl_4 evoked liver damage in rats. The extract showed a dose dependent activity. Methanolic extract showed maximum protection at a dose of 400 mg/kg.

Kimbokota and Torto (2013) investigated attractive capacity of *G. gynandra* against male *Bactrocera invadens*. *B. invadens* male flies were attracted to *G. gynandra* starting from 6.30 am to 12.30 pm in the field. The highest number of flies attracted was 66.26 ± 1.05/ plant/days showing a strong correlation during the day. Two compounds were recognized to exhibit antennae response of the male *B. invadens*. Results have shown the collaboration between a non-host plant and an invasive pest.

Thenmozhi *et al*. (2013) performed qualitative and quantitative microscopy and phytochemistry of *C. gynandra*. The microscopical evaluation showed the presence of mesophyll tissue, venation pattern, anomocytic stomata and glandular trichomes. Phytochemical screening revealed the presence of various phytoconstituents like glycosides, alkaloids, phenolic compounds, carbohydrates, tannins, flavanoids and so on.

Nyalala *et al*. (2013) isolated volatile compounds from the leaves of the African Spider plant with bioactivity against Spidermite, *Tetranychus urticae*. Acetonitrile was absent in the homogenized tissues of five lines of *G. gynandra*, calculated over last two seasons. Six compounds from thirteen volatile compounds isolated from *G. gynandra* were assessed for the activity. Spider mite were completely inactive after a 2 h treatment to butyl isothiocyanate, 2, 4-heptadienal or β-cyclocitral. The same intensity of inactivity was observed after exposure to 5.0 µl of (Z) 2-pentenol or a 25 µl volume of 50% v/v Z3 hexenal or 5% w/v methyl isothiocyanate. Excess of β-cyclocitral post 24 h of exposure to its dose of 5 µl in a 100 ml air space showed a 6% recovery of the spider mites but higher concentrations show zero recovery. These compounds may be considered as potential repellants for spider mites in roses.

Sridhar *et al*. (2014) assessed antimicrobial activity of methanolic extracts of plants against four bacteria and four fungal cultures by disc diffusion assay method. Streptomycin and nystatin were used as standards for bacterium and fungi respectively. MIC of the extracts was screened through micro broth dilution method. The antimicrobial efficiency was assessed by their zone of inhibition as well as activity index values.

Deepashree and Gopal (2014) evaluated antioxidant property of *C. gynandra.* and detected phytoconstituents that might have a role in possessing the activity. *In vitro* antioxidant protocols like DPPH radical scavenging assay, reducing power assay and metal chelation assay were carried out to assess its antioxidant potency. Phytochemical screening exhibited the presence of flavonoid, alkaloid, steroid and tannins in different solvents. Both methanol and acetone extract have antioxidant activity when compared to other extracts.

Shanmuganathan and Karthikeyan (2014) studied antioxidant activity of plant by DPPH scavenging efficiency of aqueous and ethanolic extracts (100-500 µg/ml) treated with L-arginine and *C. gynandra*. The standard used was ascorbic acid. This showed that ethanolic extract exhibited more activity than other extracts tested.

Sabir and Aziz (2015) determined the surviving methods of *G. gynandra*. The plants exhibited Deevey type I survivorship curve with mortality more concentrated in the last stage of life. An initial rise in the number of plants was observed with the onset of rainy season. The population size declined due to the hazardous environmental conditions, like storm, pollution, wind, short moisture period *etc*. A gradual increase in the plant height (50-90 cm) shows an increase in the population with the time. In the early stages of life, biomass allocation was mainly towards vegetative parts like leaf, *etc*., followed by development of reproductive parts in the third week of growth.

Rao and Kumar (2015) performed phytochemical profiling and antioxidant activity of ethyl acetate extracts of *G. pentaphylla*. Phytochemical profile showed the presence of flavonoids, alkaloids, terpenoids, saponins, tannins, steroids, quinones, proteins and cardiac glycosides. The plant was collected from the fields of Chengalpattu, Tamil Nadu, India. High amounts of alkaloids, terpenoids and steroids and low amounts of proteins, saponins, flavonoids and cardio glycoside were observed. Potent antioxidant activity was exhibited by the plant extract at a range of 5 mg.

Wasonga *et al*. (2015) carried out characterization of selected spider plant accessions from Kenya and South Africa to characterize those with distinct morphological traits for future development programs. As a part of the study, thirty two accessions of Spider plant, 23 from Kenyan gene bank and nine from South African gene bank were planted at the University of Nairobi's kabete field station with 3 replications. Eleven morphological features based on modified FAO (1995) Spider plant descriptors were used in characterization. Features evaluated were growth habit, colour of leaf, stem, petiole and flower, hairiness of petiole and stem, leaf pubescence, leaf shape and number of leaflets per leaf. The scored data were assessed by using some software like Darwin software v6 and Genstat v14. Shannon diversity index (H), multivariate methods of active component analysis and hierarchical clustering analyses were carried out for all the characters. The relatively high range of dissimilarity was found in this study among the accessions for characters evaluated, especially extensions from the two different countries, indicates high chances for genetic improvement of the crop through cross breeding from different geographical regions.

Mangaiyarkarasi and Ilyas (2015) carried out phytochemical screening and fluorescence analysis of ethanolic leaf extract of *C. gynandra.* Phytochemical screening helps in standardizing the herbal preparations and also relates the constituents to their therapeutic uses. In this study, dried leaf material was grounded to coarse powder followed by the extraction with ethanol. The dry powder of leaf sample was observed under U.V. light to evaluate the fluorescence. Phytochemical screening of leaf crude extracts of *C. gynandra* in different solvents like methanol, ethanol, petroleum ether, chloroform and acetone was carried out. The quantitative studies showed that leaves of *C. gynandra* contain alkaloids, carbohydrates, glycosides, saponins, phytosterols, proteins, flavonoids and lignin. This may be helpful in the detection of the bioactive principles and in identifying lead compounds.

Abdullah *et al*. (2016) gathered information from various sources and published as review article on the Cleomaceae family. It summarizes the researches carried out on this genus focusing with its chemical constituents and the biological activity. It was found that the plants of this genus contain many chemical components like essential oils, terpenes, flavonoids, glucosinolates, anthocyanins and alkaloids. It also exhibits different biological activities such as antidiabetic, anticancer, anti-schistomiasis, antibacterial, antidiarrheal, analgesic, anti-inflammatory and antimalarial.

Shanmuganathan and Karthikeyan (2016) carried out phytochemical screening and antioxidant activities on shoots of *C. gynandra.* Free radicals are the cause of several metabolic disorders. Nullifying the effects of free radicals can be done through the phytochemicals and secondary metabolites of plants, which will lead to prevent or cure many diseases. The present study dealt with the identification and quantification of phytochemicals in aqueous, ethanolic extracts of the shoots of the plant in *vivo* and *in vitro* models. It revealed the presence of active phytochemicals such as alkaloids, flavonoids, phenols, tannins, saponins, terpenoids etc. This study also exhibited the antioxidant activity of aqueous, ethanolic extracts of *in vivo* and *in vitro* shoots of *C. gynandra through* DPPH scavenging method. The ethanolic extracts *in vitro* shoots exhibited higher antioxidant activity than the other extract.

Imanirampa and Alele (2019) studied antifungal property of *C. gynandra* against *Tinea capitis*. It was performed by broth dilution method. Testing on clinical isolates of three common fungal strains obtained responsible for *Tinea capitis*. Assessment was done to check the minimum inhibitory concentration (MICs) and the minimum fungicidal concentrations (MFCs) of the extracts. Both plant extracts exhibited antifungal activity which altered the type of organism of the fungal isolates. The ethanol extract exhibited significant antifungal activity of the aqueous extract depicted by the MIC values.

Aubry *et al*. (2016) carried out studies on transcriptome signature for guard cells from the C4 plant *G. gynandra.* Compared with C3 leaves, the carbon-concentrating mechanism of C4 plants allows photosynthetic operation at lower stomatal conductance, and as a result, transpiration is reduced. Here, we characterize transcriptomes from guard cells in C3 *Tareneyahas sleriana* and C4 *G. gynandra*. Most ion and CO_2 signaling modules remain intact at the transcript level in guard cells from C3 and C4 species, but major differences in transcripts linked with carbon-related pathways were identified. Genes associated with C4 photosynthesis were highly expressed in guard cells of C4 compared with C3 leaves. Furthermore, two major patterns of cell-specific C4 gene expression within the C4 leaf were identified. Genes already linked with preferential expression in the bundle sheath exhibited constantly declining expression from bundle sheath to mesophyll to guard cells. In the second, expression was high in the mesophyll compared to guard cells and bundle sheath.

Dube (2017) performed pharmacognostic parameters and performed phytochemical analysis of *G. gynandra.* Morphology, microscopy and leaf constants and other physicochemical constants were carried out. Microscopic study reveals dorsiventral nature of leaf, huge number of glandular trichomes on epidermis, vascular bundles and anomocytic type of stomata. Total ash, acid insoluble ash and water soluble ash were found to be 18% w/w, 3.5% w/w and 65.5% w/w, respectively. Water soluble and alcohol soluble extractive values were found to be 16.2% w/w and 7.1% w/w, respectively, and moisture content was found to be 9.87% w/w. Various leaf constants were found as stomatal number (upper-9.7-11.5 and lower-15.3-18), stomatal index (upper-13.9%-16.42% and lower-25%-26.68%), vein islet number (9-13), vein let termination number (6-9) and palisade ratio (5-6.6).

Trilochana *et al*. (2017) evaluated the hypoglycaemic and antidiabetic property of aqueous extract of root of *G. gynandra* in normal and diabetic rats. The aqueous extract of root was screened at 3 dose levels (100, 200 and 400 mg/kg each) in rats. In each case, the initial test was performed at a dose of 100 mg/kg. The results were found to be comparable with standard, Tolbutamide at a dose of 40 mg/kg. The study proved that the herb has hypoglycemic property which is comparable with Tolbutamide.

Houdegbe *et al*. (2018) studied various practices for enhancing growth and leaf yield. This study assessed the effects of two seedling ages at transplanting, three planting densities, three second harvest timings and three cutting heights on growth and yield in *G. gynandra*. The results revealed that two weeks and three weeks old seedlings could be utilized for the cultivation purpose. Seedling age, planting density and consecutive cutting time had impact on growth and biomass yield. Increasing planting density decreased plant growth but increased biomass yield. Planting density of gave the highest biomass yield. Cutting height greater than 15 cm facilitates a better regrowth and higher yield. Harvesting plants two weeks after the first harvest gave more yields but in second harvest was less.

Partha and Satya (2018) performed the pharmacological screening and phytochemical activity of *C. gynandra* of two mutant variety, to provide a common platform for research potential of both the mutant varieties of *G. gynandra* . Review reveals that the plant possesses a broad range of pharmacological applications, such as anti-inflammatory, free radical scavenging, anticancer, immuno-modulatory and anti-diabetic agents. To study its pharmacological importance, there is an enormous amount of phytochemicals endorsement. Scientific perusal reveals that different parts of the plant have an immense medicinal importance which proves its traditional use around the globe. To date, there is not much research done for this mutant variety to validate its pharmacological importance. Therefore, research needs to be scrutinized to compare the medicinal claims of the pink mutant variety in the bio-diverse region of North-East India.

Dube (2018) screened the different extracts of *G. pentaphylla* for phytochemical analysis and for milk evoked eosinophilia and leucocytosis in experimental mice. They have shown alkaloids, flavonoids and saponins. All the extracts were found to be effective against eosinophilia and leucocytosis. The aqueous and methanolic extracts showed promising inhibition when compared to dexamethasone.

Sogbohossou *et al*. (2018) carried out survey on breeding orphan leafy vegetable species. Important steps in genome-enabled orphan leafy vegetables improvement are identified and discussed in the context of *G. gynandra* breeding. This study throws light on information regarding improving leaf yield, phytonutrient content, organoleptic quality, resistance to biotic and abiotic stresses and post-harvest management.

Santhosha (2019) investigated protective effect of methanolic extract of whole herb against cerebral ischemia induced brain damage in albino Wister rats. Cerebral ischemia was induced by occluding carotid artery using nylon thread followed by reperfusion. Animals were sacrificed and immediately brains were isolated and analyzed for various biochemical parameter estimation, brain infarct area and histopathological studies. Biochemical estimations were measured and results were expressed in terms of Mean ± SEM by using ANNOVA software. Methonolic extract of *G. gynandra have* proven to have protective effect. Of all the three doses, 300 mg/kg dose of the drug have shown maximum protective effect when compared to other two doses.

Chataika *et al*. (2021) identified spider plant accessions with superior levels of dietary phytochemicals and anti oxidative activity for use in nutraceutical breeding. Total phenolic acids, tannins and anthocyanins were extracted and quantified using the Folin-ciocalteau colorimetric, spectrophotometric and pH differential methods, respectively. Antioxidant activity was determined using phosphomolybdenum method. Results showed significant variation in levels of total phenolic compounds, tannins, anthocyanins, and antioxidant activity (p<0.05). Amongst the Spider plant accessions and regions of origin; ODS-15-037 (464 mg TAE/g DW), ODS-15-053 (270 mg GAE/g DW), and BC-02A (127 mg cyanidin-3-glucoside/g DW) had the highest levels of total tannins, phenolic compounds, and anthocyanins, respectively.

Table 2: Pharmacological effects of different parts of the plant with emphasis on their chemical constituents

S.No.	Plant part used	Chemical constituents	Pharmacological effect	Reference
1.	Leaf	Alkaloids, resin, tannins and volatile oils	Arterial hypertension and constipation	Sharaf *et al.,* 1960
2.	Shrub	Anti-tick property	Repellent property	lwande *et al.,* 1999
3.	Stem	Volatile oils	Antibacterial and antifungal properties	Ajaiyeoba *et al.,* 2000
4.	Whole plant	Flavones and flavonols	Cancer cell lines	George *et al.,* 2005
5.	Seed	Cleomin, hexacosanol, free β-sitosterol and kaempferol	Antioxidant activity	Sivanesan *et al.,* 2007
6.	Whole herb	Volatile oil	Asthma	Latha *et al.,* 2007
7.	Leaves	Paste/Puree	Scurvy	Vanden and Heever *et al.,* 2006
8.	Leaves, roots, stems, seeds and seed pods	-	Antimycotic, antibacterial	Borgio *et al.,* 2008
9.	Whole plant	NA	Spider mite-control	Nyayala *et al.,* 2007
10.	Seed	Volatile oils	Anthelminthic activity	Jalalpure *et al.,* 2007
11.	Leaf	Tannins and alkaloids	Anti-bacterial activity	Borgio *et al.,* 2008
12.	Leaf	Flavonoids and tannins	Anti-nociceptive activity	Ghogare *et al.,* 2009
13.	Whole plant	Primary and secondary metabolites	Anti-microbial activity	Uma *et al.,* 2009
14.	Whole plant	Secondary metabolites	Anti-helminthic activity	Ajaiyeoba *et al.,* 2016
15.	Whole plant	Secondary metabolites	Liver protective activity	Sambasiva *et al.,* 2013
16.	Whole plant	NA	Attractive capacity against male Bactrocera invadens	Kimbokota *et al.,* 2013
17.	Leaves	Volatile oils	Spider mite-control	Nyalala *et al.,* 2013
18.	Whole plant	Tannins and alkaloids	Antimicrobial activity	Sridhar *et al.,* 2014
19.	Whole plant	Flavonoid, alkaloid, steroid and tannins	Anti oxidant property	Deepa Shree and Goyal, 2014
20.	Whole plant	Flavonoid, alkaloid, steroid and tannins	Anti oxidant property	Shanmuganathan and Karthikeyan, 2016

21.	Whole plant	Alkaloids, terpenoids and steroids	Antioxidant property	Ram Krishna *et al.*, 2015
22.	Shoots	Alkaloids, flavonoids, phenols, tannins	Antioxidant property	Shanmuganathan *et al.*, 2016
23.	Whole herb	Alkaloids, terpenoids and steroids	Antifungal	Imanirampa *et al.*, 2016
24.	Roots	-	Antidiabetic property	Trilochana *et al.*, 2017
25.	Whole herb	Alkaloids, flavonoids and saponins	Eosinophilia and leucocytosis	Dube *et al.*, 2018
26.	Whole herb	Alkaloids, flavonoids and saponins	Neuroprotective activity	Santhosha, 2019

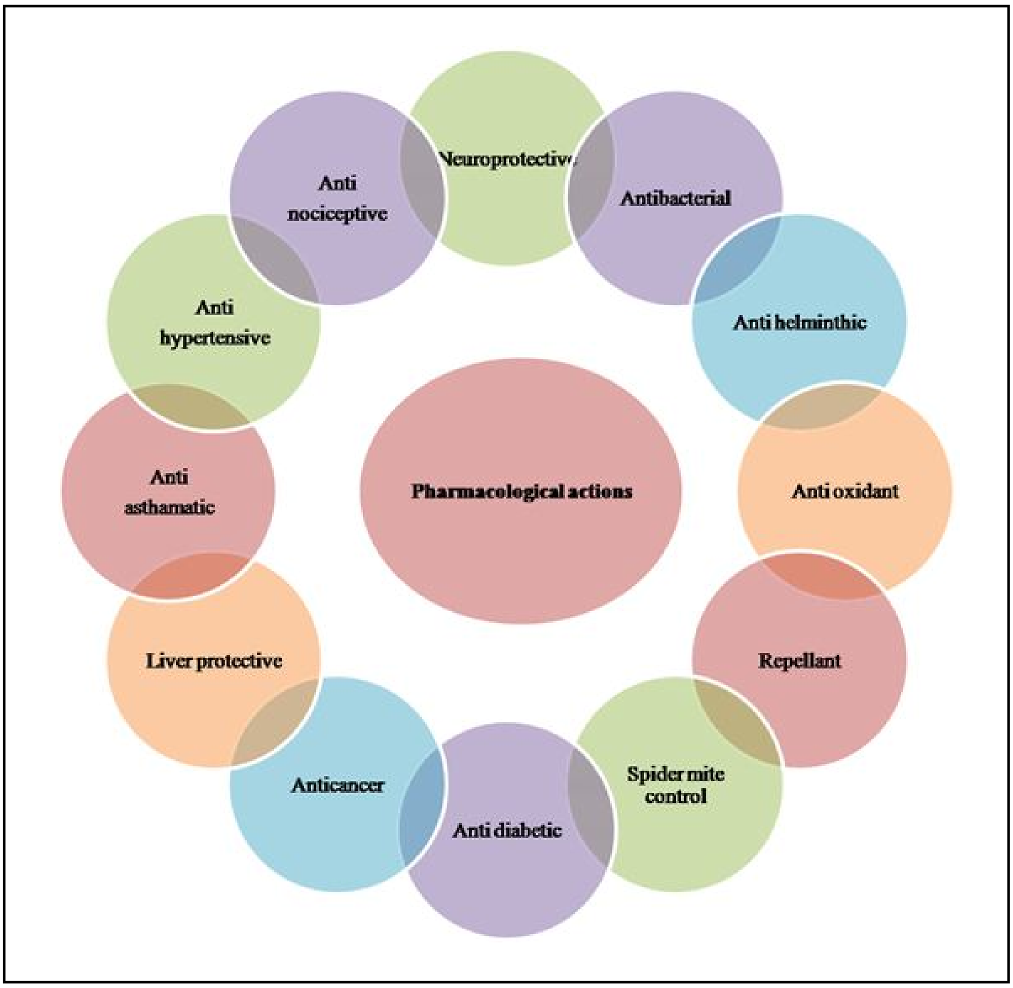

Figure 3: Pharmacological actions of *G. gynandra*.

5. Conclusion

G. gynandra possesses many potent activities which are used traditionally in Ayurveda. The plant has also been used as nutraceutical where its leaves can be cooked and eaten to combat malnutrition. It consists of many phytoconstituents which play role in various pharmacological activities of plant. Different phytoconstituents are present in different parts of the plant and all parts of the plant are useful medicinally. Major phytoconstituents include cardiac glycosides, carotenoids, flavonoids, saponin, cyanogenic glycosides, triterpenes, sugars, tannins and so on. These are responsible for its protective action against oxidation, diabetes, hepatotoxicity, hypertension, scurvy, cancer, helminths, asthma, microbes and many more to explore. Over all, review throws light on various research activities carried on the plant paving way for further research to be carried out to explore many more uses of the plant. Since it is used as nutraceutical, toxicity of the plant is believed to be less, aiming to improve its usage in Pharmaceutical and food industries.

Conflicts of interest

The authors declare no conflicts of interest relevant to this article.

References

Aarati, P.; Divya, C.S. and Reshma, R. (2022). Evaluation of efficacy of Ayurvedic formulation Tulha tablets in patients suffering from menstrual irregularities, Ann. Phytomed, **11**(2): 280-283.

Abdullah, W.; Elsayed, W.M.; Abdelshafeek, K.A.; Nazif, N.M. and Singab, A. (2016). Chemical constituents and biological activities of cleome genus: A brief review, International Journal of Pharmacognosy and Phytochemistry, **8**(5):777-87.

Ajaiyeoba, E.O. (2000). Phytochemical and antimicrobial studies of *Gynandropsis gynandra* and *Buchholzia coriaceae* extracts, African Journal of Biomedical Research, **3**(3):161-165.

Anbazhagi, K.; Kadavul, G. and Suguna, P.A.J.A. (2009). Studies on the pharmacognostical and *in vitro* antioxidant potential of *C. gynandra* Linn. leaves, Natural Products Radiance, **8**(2):151-157.

Ajay, S.; Amit, K. and Rupesh. (2023). Nanoemulsion: A futuristic approach to disease elimination for food safety, Ann. Phytomed, **12**(1):180-186.

Aubry, S.; Aresheva, O.; Reyna-Llorens, I.; Smith-Unna, R.; Hibberd, J.M. and Genty, B. (2016). A specific transcriptome signature for guard cells from the C4 plant *Gynandropsis gynandra*, Plant Physiology, **170**(3):1345-1357.

Borgio, J.F.; Thorat, P.K. and Lonkar, A.D. (2008). Antimycotic and antibacterial activities of *Gynandropsis pentaphylla* DC extracts and its phytochemical studies, The International Journal of Microbiology, **5**(2):1-4.

Borgio, J.F.; Thorat, P.K. and Lonkar, A.D. (2008). Toxicity of *Gynandropsis pentaphylla* DC extracts against microbial and its phytochemical profile, Ethnobotanical Leaflets, **2008**(1):39.

Chataika, B.Y.; Akundabweni, L.S.M.; Houdegbe, A.C.; Achigan-Dako, E.G.; Sibiya, J. and Masamba, K. (2021). Dietary phytochemical screening of Spider Plant (*Gynandropsis gynandra* (L.) Briq.) accessions from Africa and Asia to identify genotypes for use in nutraceutical breeding. Frontiers in Sustainable Food Systems, pp:344.

Deepashree, C.L. and Gopal, S. (2014). Evaluation of *C. gynandra* for its chemical composition, antioxidant potential and detection of flavonoids using Thin Layer Chromatography, International Journal of Science and Research, **3**(10):58-60.

Dube, U.S. and Nirmal, S.A. (2018). Effect of *Gynandropsis pentaphylla* leaves on milk-induced eosinophilia and leucocytosis in mice. International Journal of Pharmacognosy, **5**(3):177-181.

Dube, U.S.; Sunil, A. and Nirmal. (2017). Pharmacognostic and preliminary phytochemical screening of leaves of *Gynandropsis gynandra*, World Journal of Pharmaceutical Research, **6**(13):934-943.

Ghogare, U.R.; Nirmal, S.A.; Patil, R.Y. and Kharya, M.D. (2009). Antinociceptive activity of *Gynandropsis gynandra* leaves, Natural Product Research, **23**(4):327-333.

Houdegbe, C.A.; Sogbohossou, E.D. and Achigan-Dako, E.G. (2018). Enhancing growth and leaf yield in *Gynandropsis gynandra* (L.) Briq. (Cleomaceae) using agronomic practices to accelerate crop domestication, Scientia Horticulturae, **233**:90-98.

Imanirampa, L. and Alele, P.E. (2016). Antifungal activity of *C. gynandra* L aerial parts for topical treatment of Tinea Capitis: An *in vitro* evaluation, BMC Complement Alternative Medicine, **16**(1):194.

Jalalpure, S.S.; Alagawadi, K.R.; Mahajanashetti, C.S.; Shah, BN.; Singh, V. and Patil, J.K. (2007). *In vitro* anthelmintic property of various seed oils against *Pheritima posthuma*, Indian Journal of Pharmaceutical Sciences, **69**(1):158.

Kimbokota, F. and Torto, B. (2013). Candidate attractants for *Bactrocera invadens* (Diptera: Tephritidae) male flies from *Gynandropsis gynandra* (Capparidaceae), Journal of Natural Science and Research, **3**:35-44.

Latha, G.S.; Lakshmi, V.V.; Rani, H.S. and Murthy, K.J. (2007). The effect of immunotherapy with *Gynandropsis gynandra* pollen in atopic asthma patients, Lung India, **24**(4):124.

Lwande, W.; Ndakala, A.J.; Hassanali, A.; Moreka, L.; Nyandat, E. and Ndungu, M. (1999). *Gynandropsis gynandra* essential oil and its constituents as tick (*Rhipicephalus appendiculatus*) repellents, Phytochemicals, **50**(3):401-405.

Mangaiyarkarasi, A. and Ilyas, M.H.M. (2015). Phytochemical screening and fluorescence analysis of *C. gynandra* L. leaves, International Journal of Current Research and Biosciences, **2**(9):58-65.

Mishra, S.S.; Moharana, S.K. and Dash, M.R. (2011). Review on *Cleome gynandra*, International Journal of Research in Pharmacy and Chemistry, **1**:681-689.

Nyalala, S. and Grout, B. (2007). African spider flower *C. gynandra* L./ *Gynandropsis gynandra* (L.) Briq. as a red spider mite (Tetranychus urticae Koch) repellent in cut-flower rose (*Rosa hybrida* L.) cultivation, Scientia Horticulturae, **114**(3):194-198.

Nyalala, S.O.; Petersen, M.A. and Grout, B.W. (2013). Volatile compounds from leaves of the African spider plant (*Gynandropsis gynandra*) with bioactivity against spider mite (*Tetranychus urticae*), Annals of Applied Biology, **162**(3):290-298.

Ogunmefun, O.T. and Ajaiyeoba, E.O. (2016). Anthelmintic study of *Buchholzia coriacea* and *Gynandropsis gynandra* (fam. Apparidaceae). Asian Journal of Science and Technology, **4**(11):067-070.

Partha, P.A. and Satya, B.P. (2018). Medicinally important plant *C. gynandra*: A phytochemical and pharmacological explanation, Asian Journal of Pharmaceutical and Clinical Research, **11**(1):21-29.

Pettit, G.R.; Meng, Y.; Herald, D.L.; Stevens, A.M.; Pettit, R.K. and Doubek, D.L. (2005). Antineoplastic agents 540. The Indian *Gynandropsis gynandra* (Capparidaceae), Oncolology. Research, **15**(2):59-68.

Rao, E.S.; Rao, P.R.; Rao, B.G. and Rao, T.M. (2013). Evaluation of hepatoprotective activity of *Gynandropsis gynandra*, Journal of Pharmacy Research, **6**(9):928-932.

Rao, M.R. and Kumar, S.S. (2015). Preliminary phytochemical analysis and antioxidant properties of *Gynandropsis pentaphyla*, Der Pharmacia Lettre, **7**:12.

Rekha, R. W. (2021). Authentication of herbal products to attract global markets. Ann. Phytomed., **10**(2):1-3.

Sabir, S. and Aziz, S. (2015). Demographic study of *Gynandropsis gynandra*: A desert annual. Pakistan Journal of Botany, **47**(2):533-535.

Santhosha, D. (2019). Pharmacognostic Study, phytochemical screening and neuroprotective activity of methanolic extract of *Gynandropsis gynandra* against transient global ischemia induced brain damage in rats. Asian Journal of Research in Pharmaceutical Sciences, **9**(3):156-162.

Santhosha, D. and Ramesh, A. (2022). Pharmacognosy, phytochemistry and pharmacological profile of *Gmelina asiatica* L.: A review, Ann. Phytomed, **11**(2):205-213.

Sastry, D.J. (2014). Dravyaguna vijnana vol. II. Varanasi, Chaukhambha Orientalia.

Shanmuganathan, T. and Karthikeyan, A.V.P. (2014). Free radical scavenging activity of aqueous and ethanolic extracts of wild and L-Arginine treated *C. gynandra*, International Journal Pharmaceutical Science and Research, **5**(7):346-349.

Shanmuganathan, T. and Karthikeyan, A.V.P. (2016). Phytochemical analysis and antioxidant activities of *in vivo* and *in vitro* shoots of *C. gynandra* L. International Journal Sciences Research, **5**(6):2319-7064.

Sharaf, A. and Hamidi, A. (1970). A pharmacological study of *Gynandropsis gynandra* L. grown in Egypt, Planta Medica, **8**(2):160-163.

Sivanesan, D. and Hazeena, B.V. (2007). Preventive role of *Gynandropsis gynandra* L. against aflatoxin B1 induced lipid peroxidation and antioxidant defense mechanism in rat. Indian Journal of Experimental Biology, **45**(3):299-303.

Sogbohossou, E.D.; Achigan-Dako, E.G.; Maundu, P.; Solberg, S.; Deguenon, E.M. and Mumm R.H. (2018). A roadmap for breeding orphan leafy vegetable species: A case study of *Gynandropsis gynandra* (Cleomaceae), Horticulture Research, **5**(1):2.

Sridhar, N.; Kiran, B.V.; Sasidhar, D.T. and Kanthal, L.K. (2014). *In vitro* antimicrobial screening of methanolic extracts of *Cleome chelidonii* and *C. gynandra*, Bangladesh Journal of Pharmacology, **9**(2):161-166.

Susmita, G.; Karishma, R.; Himanshu, D. and Usha, M. (2020). Screening of selected plants for their effectiveness in the treatment of kidney stone, Ann. Phytomed, **9**(1):213-217.

Thenmozhi, S.; Subasini, U.; Kameshwaran, S.; Dhanalakshmi, M. and Victor, R.G. (2013). Morpho-anatomical and preliminary phytochemical studies of leaves of *Gynandropsis pentaphylla* Linn. International Journal of Pharmaceutical Life sciences, **4**(7):2800-2809.

Trilochanas, Y.; Babu, D.J. and Rao, P.R. (2017). The study of antidiabetic activity of aqueous extract of root of *Gynandropsis gynandra*. Indian Journal of Research in Pharmacy and Biotechnology, **5**(1):13.

Uma, B.; Prabhakar, K.; Rajendran, S. and Sarayu, Y.L. (2009). A study on phytochemical screening and antimicrobial activity of *C. gynandra* L. against infectious infantile diarrhea. Pharmacology Online, **2**: 12-16.

Vanden, H.E. and Venter, S.L. (2006). Nutritional and medicinal properties of *C. gynandra*, International conference on indigenous vegetables and legumes: Prospectus for fighting poverty, Hunger, and Malnutrition, pp:127-130.

Wasonga, D.O.; Ambuko, J.L.; Chemining'wa, G.N.; Odeny, D.A. and Crampton, B.G. (2015). Morphological characterization and selection of spider plant (*C. gynandra*) accessions from Kenya and South Africa, Asian Journal of Agricultural Sciences, **7**(4):36-44.

Citation **D. Santhosha and S. Dinesh mohan (2023). Pharmacognosy, phytochemistry and pharmacological profile of *Gynandropsis gynandra* L.: A review. Ann. Phytomed., 12(2):275-283. http://dx.doi.org/10.54085/ap.2023.12.2.33.**