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Review Article

REVIEW ON CLEOME GYNANDRA

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ABSTRACT

Cleome gynandra is an abundantly available species and grows as a weed in common barren land and in crop fields throughout India .In all over the world in different countries it is used to treat many diseases in their traditional system and it is also used in various traditional culinary systems for its remarkable nutritional and antioxidant properties. In India alone it is used by the traditional healers for many diseases e.g. .epilepsy, irritable bowel syndrome and in protozoal and worm infections. The high protein and amino acids, minerals content of this plant can make this as a highly economically important that can be grown and cultivated easily. In this review article through various established facts regarding the medicinal applications of cleome gynadra has been cited regarding the Immunomodulator, Antioxidant, Anticarcinogenic, Analgesic properties etc. Analysing all these established properties cleome gynandra may be a promising drug in future. Taking into account the essential mineral content, free radical scavenging properties and polyphenolic content the possible antidiabetic drug from cleome has been discussed.

Keywords: Cleome gynandra, Anti-Diabetic properties, Polyphenolic, Free radical.

INTRODUCTION

Cleome gynandra is used as a medicinal plant and can be found in all over world .It grows as a weed in paddy fields and also in road sides and in open grass lands. In India it is never cultivated but grows spontaneously everywhere. Different species of Cleome can be found in all states of India. This article briefly reviews the botany, pharmacology, biochemistry, folkloric, traditional medical applications of the plant and also different possible medical and therapeutic applications established through various laboratory researches and papers. The medicinal application of this plant is also described in Ayurvedic pharmacopoeia of India and also in other ancient medical texts. In Ayurvedic medicine it is a chief constituent in ***Narayana Churna.*** In Ayurveda it is used as an Anthelmentic, in ear diseases, pruritis and several other diseases like gastro intestinal disorders and gastrointestinal infections etc[1]

This is an attempt to compile and document information on different aspects of Cleome gynanadra and highlight the need for research and development.

Also by analysing all the biochemical and medicinal properties the possible anti diabetic application is discussed.

Fig.1-Cleome gynandra Whole plant

Botanical Description[2, 3]

Morphology-It is an erect, annual herb up to 250-600 mm tall; much branched and sometimes becomes woody with age. **Stem-** The stem is sticky with glandular hairs and marked with longitudinal parallel lines.

Leaves-Leaves are palmately compound, with 3-5 leaflets. The leaf stalk is 20-50 mm long with glandular hairs. The leaflets radiate from the tip of the leaf stalk, are 20-100 x 8-40 mm, smooth or with glands, and taper toward the base; on the under surface, are smooth to finely glandular, and often with scattered multi cellular hairs on the main nerves.

Fig.2-A flower and fruit bearing twig

Inflorescence- The inflorescence is a terminal raceme, many-flowered, elongating in fruit; the bract is 3-foliolate to simple above, resembling the leaves but smaller and sessile. The flower stalk is 10-20 mm long with glandular hairs. Petals are white, sometimes fading to rose pink, 10-20 x 3-5 mm, rounded at the apex, abruptly narrowed to a basal claw.

Flowers -bisexual, bracteate, white or tinged with purple

Fruits-The fruits are in capsule form. The capsule is linear, sub-erect to spreading, 30-150 x 2.5-5 mm; the persistent style is 2 mm long and the valve is thin-textured, glandular with hairs. The seeds are brown, circular in outline, 1.5 mm in diameter, with an obscurely netted surface.

Microscopic structures[1, 2]

Dark brown, oily; under microscope shows a number of fragments of epidermis of testa consisting of thin-walled, polygonal cells; groups of cells, resembling like stone cells, reddish-brown with non-lignified walls; a large number of oval, rounded or irregularly shaped protein bodies; starch and crystals absent[1]

Leaf thickness ranges from 112-398 µm. Upper epidermis single layered, large, slightly deep, tubular cell contains thick lamellar cuticle. Multiseriate glandular hairs embedded in both surfaces, foot 2-3 celled embedded in epidermis, bi-celled stalk, large columnar, head is about 3-5 tiered clavate. Mesophyll consists of palisade and spongy parenchyma; palisade cells are adaxial hypodermal, single layered, long rectangular with little inter cellular spaces, chloroplast abundant: spongy parenchyma 2-3 layered with large, intercellular spaces. Vascular bundles large, collateral and arc-shaped in primary veins, small and round in secondary veins. Xylem towards adaxial side, phloem in abaxial, bundle sheath large, parenchymatous cells distinct, barrel shaped, bundles of tertiary veins buried between mesophyll cells. Lower epidermis single layered, large, thick walled; guard cells large, thick walled, vertically embedded to subsidiary cells thick-cuticle, lamellar, forming very minute outer ledges over guard cells**.**

Epidermis in surface view — The costal epidermal cells are large axially oriented 5-10 times longer than broad, rectangular to rhomboidal in shape, thick walled and straight. Intercostal cells are large and in variously shaped, thin walled, slightly to deeply sinuous. Evidently, three types of glandular hairs, namely uniseriate clavate, multiseriate-spherical and multiseriate-clavate were found in both costal and intercostal regions.

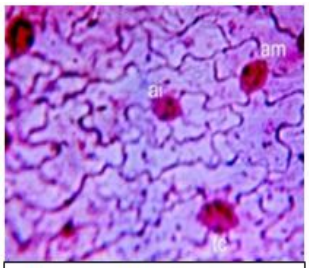

Fig.3- am (anomocytic), ai (anisocytic) and tc (tetracytic) stomata

Scientific names various species of Cleome
Gynandropsis gynandra (Linn.) Merr.
Cleome gynandra Linn.
Gynandropsis pentaphylla DC.
Cleome alliacea Blanco
Cleome alliodora Blanco
Cleome pentaphylla Linn.
Pedicellaria pentaphylla Schrank.
Sinapistrum pentaphyllum Medic.

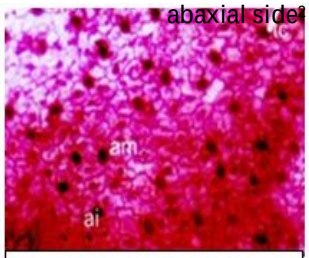

Fig.4- adaxial and abaxial epidermal cells

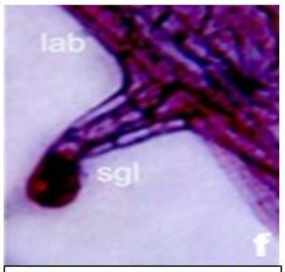

Fig.5-shaggy glandular hairs

Large shaggy glandular hairs infrequently distributed in intercostal region. Stomata distributed in costal and inter costal region, facing in all directions lying at level of epidermis; thickened at one or both the poles, medium sized, sub-spherical or elliptical stomatal dimorphism distinct. Among the three types, viz. anomocytic, anisocytic (Fig.3) and tetracytic the third type is more frequently distributed. These three types of stomata are common in both the surfaces. Stomatal abnormalities such as those with aborted guard cells with thickened poles, juxtaposed contiguous stomata and shriveled stomata are rarely 18.21 to 20.5 µm broad. Stomatal index in abaxial surface was 21.57 µm and 20.9 µm in adaxial side. The epidermal cells on the adaxial (Fig.4) sides are straite walled and abaxial epidermal cells are more undulated. Vein islet is distinct and is rhomboidal or broadly rectangular (Fig.3). The average vein islet numbers are 91.76/sq.mm and vein termination number is 116/sq.mm (Table 1). The trichomes occur along the margins of the veins; they are either uni- or multi-seriate glandular hairs, some of them as shaggy glandular hairs (Fig.5). The size of the epidermal cells and of stomata is greater in abaxial side while the number of stomata and epidermal cells are higher in adaxial as that of abaxial side[8].

Distribution

Cleome gynandra is a common, widespread herb occurring in southern Africa extending from the Limpopo, the North-West, Gauteng, Mpumalanga, KwaZulu-Natal, Free State, the Northern Cape and Namibia. Being semi-cultivated as for instance, in the Kentani District of Eastern Cape, has probably extended its distribution. It is probably a native of Africa and now widely distributed in tropical and subtropical regions throughout the world. The cleome with the large pink or white flowers that is cultivated in flower gardens is C. hassleriana, native to tropical America[3].

The natural habitat of C. gynandra is waste land and arable land with annual species as well as grasslands. *Imbamba and Tieszen (1977), Naidu et al. (1980), ajendrudu and Das (1982a, 1982b), Kumar et al. (1984) and Rao and Rejendrudu (1989)* have determined the species to have a C4 photosynthetic pathway, an adaptational mechanism that enables it to survive in drier and hot environments. It grows well up to about 1000 m asl in semi-arid, subhumid and humid climates, and is adapted to many soil types, but grows luxuriantly around rubbish dumps and soils supplied with organic manure.

The species is also native to the following regions/countries[4]
Northern Africa – Egypt, Mauritania
Western Africa – Cameroon, Ghana, Guinea, Côte d'Ivoire, Mali, Niger, Nigeria, SierraLeone
Central Africa – Angola, Burundi, Zaire
Eastern Africa – Ethiopia, Kenya, Somalia, Sudan, Tanzania, Uganda
African Islands – Madagascar, Mauritius, Reunion, Seychelles
Middle East – Oman, North Yemen
Far East – Afghanistan
Asia – Borneo, India, Java, Malaysia, Moluccas, Philippines, Sri Lanka, Sumatra, Sulawesi, Thailand
Australasia – Fiji
In India various species of the genus Cleome are found in everywhere. The most commonly available species are the ***Cleome viscosa*** with yellow flower, ***Cleome chelidonii*** with blue flower.
Common name: Wild Spider Flower, African spider-flower, cat whiskers, Bastard-mustard.

Vernacular names in India

Sanskrit : Pasugandhi,Ajagandha
Assamese : Bhutmulla
Bengali : Hurhuria, Shulte
English : Dog Mustard
Gujarat : Talvani, Dhelitalavan
Hindi : Hulhul, Hurhur, Kavalia
Kannada : Naram bele Soppu, Nayeetulasi
Kashmiri : Gandi Buti
Malayalam : Atunari vela
Marathi : Tilvan, Bhatvan, Mabli, Tilavana, Tilvant
Oriya : Anasorisia, anasorisa,Hulhulia
Punjabi : Bugra
Tamil : Nal valai, Nal velai
Telugu : Vaminta, Vayinta

Review of Phytochemistry

Preliminary phytochemical screening of the powdered leaf revealed the following compounds –Carotenoids, Cardiac glycosides, Cyanogenic Glycosides, Flavonoids, Saponins, Triterpenes, sugars, Tannins etc.[2]

CHEMICAL CONSTITUENTS OF CLEOME

The isolation of oleic acid, linolic acid, palmitic acid, stearic acid, arachidic acid and a phytosterul from seeds oil of Cleome pentaphylla Linn (1937 by Ram Nath Misra and Sikhibhushan Dutt)
The root consists of two glyco-flavonones as narringenin-4-galactoside-1 and dihydrokaemferol-4f-galactoside-2 (Chauhan and et.al.) Identification of a new glycoside-7, 3r-4-trihydroxyflavonone-5-0-a-L-rhamnopyranoside-3 were reported from the whole plant of Cleome viscosa (by S.K. Srivastava and co-workers 1979) Continuing their studies same workers in the same year reported the isolation of a new glycoside-Naringenin
Takayuki Suga et.al. reported the Cleome prenols isolated from Cleome spinosa L. These were identified as nonaprenol, decaprenol and undecaprenol, which are composed of a U terminal isoprene, three internal E-isoprene and the remaining Z-isoprene residues respectively.
S.B. Mahota and co-workers in 1979 reported the isolation of a novel diterpene lactone Cleomeolide -6 from Cleome icosandra Linn (syn Cleome viscosa Linn). From Cleome viscosa, S.K. Srivastava reported in 1980, the isolation of a new saponin identified as stigma-5, 24-(28) - diene-3B-0-a-L-rhamnoside-7. Isolation and identification of p-amyrin, lupeol, and a new glycoside from the roots of Cleome viscosa are also reported by the same author in the same year.
In 1982 a Coumarinolignoid (Cleomiscosin-B) was isolated from Cleome viscosa seeds (by Anil L. Ray and S.K.Chattopadhyaya .
In 1984 reported the isolation of kaempferol and luteolin-7-O-Glucoside by M.M. Seif El-Nasr et.al.
Some studies have been conducted to investigate the nutritional composition of the raw leaves of C. gynandra.

Table 2: summarizes the findings of these studies to date

The plant's nutritional value may vary with soil fertility, environment, plant type, plant age and the production techniques used (Chweya 1995)[4]

Nutrient	Range of values (% or mg/100 g edible parts)
Moisture content (%)	81.8-89.6
pH	5.8
Crude protein (%)	3.1-7.7
Crude fibre (%)	1.3-1.4
Carbohydrates (%)	4.4-6.4
Ether extract (%)	0.4-0.9

Total ash (%)	2.1-3.0
Potassium (mg)	410
Calcium(mg)	213-434
Magnesium (mg)	86
Sodium (mg)	33.6
Phosphorus (mg)	12
Iron (mg)	1-11
Zinc (mg)	0.76
Copper (mg)	0.46
B-carotene (mg)	6.7-18.9
Ascorbic acid (mg)	127-484
Oxalate (mg)	8.8
Total phenolic (mg)	520-910

Source: Gomez 1981; Sreeramulu 1982; Mathooko and Imungi 1994; Arnold et al. 1985; Malaise and Parent 1985; Waithaka and Chweya 1991; Mathooko and Imungi 1994; Chweya 1995; Opole et al. 1995; Sebit 1995.

Palmitic acid
Palmitoleic acid
Stearic acid
Oleic acid
Linoleic acid
Arachidic acid
Eicosenoic acid

Account for about 81% of total fatty acids, but linoleic acid is the most abundant (accounting for 59% of total fatty acids) (Table 3). Lipids have a high degree of unsaturation, as is shown by the high iodine and saponification numbers (123 and 192, respectively). Cultigens exhibit slight variation in the proportion of fatty acids and generally have lower stearic than palmitic acid contents.

Table 3: Fatty acid composition

Amino acid analysis of defatted meal has indicated that glutamic acid content is highest, followed by arginine, aspartic acid, lysine, tyrosine and histidine. As can be seen from Table 4, the composition is comparable to that of leguminous oilseeds.

Table 4: Amino acid composition of selected Zambian Cleome gynandra seed (Mnzava 1990)[3]

1	Glutamic
2	Arginine
3	Aspartic
4	Leucine
5	Valine
6	Glycine
7	Proline
8	Phenylalanine
9	Isoleucine
10	Threonine
11	Alanine
12	Serine
13	Lysine
14	Tyrosine
15	Histidine

PROPERTIES AND ACTION ACCORDING TO AYURVEDIC CONCEPT[1]

Rasa : Katu
Guna : Laghu, Ruksa
Virya : Sita
Vipaka : Katu
Karma: Sulaghni, Dipana, Hrdya, Pittala, Vatahara

THERAPEUTIC USES (AYURVEDIC)[1]

Gulma (Any tumour, lump or diverticulosis), Asthila (Prostate enlargement), Krmiroga (Worm infection), Kandu (Pruritus), Karnaroga (Ear diseases)

USE IN ALL OVER THE WORLD[4]

The vegetable is important as a leafy vegetable in the following African countries: Nigeria, Zaire, Malawi, Zimbabwe, Cameroon, Botswana, Namibia, Swaziland, Tanzania, Zambia, South Africa, Ghana, Uganda and Kenya. In India, it is eaten as a pot herb and flavouring in sauces and in Thailand it is consumed fermented in a product called 'pak-sian-dong' (FAO 1990). Indigenous knowledge possessed by rural women in Kenya indicates that C.gynandra has several nutritional uses (Opole et al. 1995). Leaves may be crushed to make a concoction that is drunk to cure diseases such as scurvy. In many cultures, boiled leaves are regarded as a medicinal meal. In other communities, leaves are boiled and marinated in sour milk for 2-3 days and eaten as a nutritious meal, which is believed to improve eyesight, provide energy and cure Marasmus. It is a highly recommended meal for pregnant and lactating women. However, in some communities, leaves boiled in water are believed to dry up a mother's milk. Eating the vegetable is believed to reduce dizzy spells in pregnant women. It is believed that regular consumption of the leaves by pregnant women will ease childbirth by reducing the length of their labour, and will help them regain normal health more quickly afterwards. In some communities, consumption of the

vegetable by pregnant women is almost mandatory. The vegetable does not appear to be a popular infant meal (for babies of up to 10 months), but is given to children from toddler age upwards. The seeds are oleiferous, containing polyunsaturated oil, which is extracted by pressure and does not need refining. They are used as bird food. The seed cake has an excellent acid spectrum and can therefore be utilized in animal feeds.

MEDICINE[2,4]

The leaves and seeds of cat's whiskers are used in indigenous medicine in many countries.

(Purseglove 1943; Anonymous 1956a, 1956b; Kokwaro 1976; Baruah and Sarma 1984; Kumar and Sadique 1987; Opole et al. 1995). The following uses have been reported.

- Sap from leaves may be used as an analgesic, particularly for headaches.
- Sap from pounded young leaves is squeezed into ears, nostrils and eyes to treat Epileptic fits and earache.
- A decoction or infusion of boiled leaves and/or roots is administered to:

- facilitate childbirth in pregnant women
- treat stomach-ache and constipation
- treat conjunctivitis
- treat severe thread-worm infection
- relieve chest pains.

- Arthritis is treated with the leaves.
- The leaves have anti-inflammatory properties.
- The bruised leaves are rubefacient and vesicant, and are used to treat headache, neuralgia, rheumatism and other localized pains. They are rubbed on the affected Parts of the body, or applied as a poultice. Care must be taken to remove the application before it causes blisters, however.
- In Taiwan Cleome gynandra is used to treat dysentery, gonorrhoea, malaria, rheumatoid arthritis. In India The plant has been traditionally used as an anthelmentic and rubefacient. Leaves are applied externally over the wounds to prevent the sepsis. The plant also used in the treatment of malaria, piles, rheumatism and in tumour. The decoction of the root is used to treat fevers.

Laboratory experimental trials on animal models, conducted by different laboratories and authors

Anti-inflammatory activity of stems of Gynandropsis pentaphylla Linn[5, 6]

The thermal stimuli in hotplate test and the writhing response of the animals to an intra-peritoneal injection of noxious chemical are used to screen both peripherally and centrally acting analgesic activity. Acetic acid causes analgesia by liberating endogenous substances that excite the pain nerve endings. From the results it is apparent that the AEGP (Aqueous Extract of Gynandropsis pentaphylla) showed a significant antinociceptive effect in the hotplate test and writhing response, which is comparable to that of the standard. Studies demonstrate that various flavonoids such as rutin, quercetin, luteolin, hesperidin and biflavonoids produced significant antinociceptive and anti-inflammatory activities. There are also a few reports on the role of tannins in antinociceptive and anti-inflammatory activities. NSAIDs can inhibit cyclo-oxygenase in peripheral tissues, thus interfering with the mechanism of transduction in primary afferent nociceptors. The mechanisms of antinociceptive action of AEGP could be due to the presence of flavonoids and mediated through central and peripheral mechanisms

Most of the non steroidal anti-inflammatory drugs (NSAIDs) have well balanced anti-inflammatory and ulcerogenic activities, which are considered to be due to PG (prostaglandins) synthetase inhibitor activity. The Flavonoids and tannins in AEGP are reported to inhibit PG synthesis.

Free radical scavenging activities[2,7]

The generation of free radicals has been implicated in the causation of several diseases of known and unknown aetiologies such as, rheumatoid arthritis, diabetes, cancer, etc., and compounds that can scavenge free radicals have great potential in ameliorating these disease processes. The laboratory experimental study on animal models exhibited the anti-oxidant potential of Cleome gynandra leaf extract at a dose of 150 mg/kg body weight for a 30 days trial on adjuvant induced arthritis in experimental rats. Oral administration of C. gynandra leaf extract significantly increased the levels of lipid peroxidase and activities of catalase, glutathione peroxidase and decreased the levels of reduced glutathione and superoxide dismutase activity in arthritis induced rats.

The free radical scavenging activity of the plant was further evidenced by histological observations made on the limb tissue. The presence of biologically active ingredients and vital trace elements in the leaves readily account for free radical scavenging property of C. gynandra.

Anticancer activity of Cleome gynandra on Ehrlich's Ascites Carcinoma treated mice[8]

Anticancer activity of methanol extract of Cleome gynandra (MECG) was evaluated in Swiss albino mice against Ehrlich Ascites Carcinoma (EAC) cell line at the doses of 200 and 400 mg/kg body weight intraperitoneally. MECG showed significant decrease in tumor volume, viable cell count, tumor weight and elevated the life span of EAC tumor bearing mice. Hematological profile such as RBC, hemoglobin, WBC and lymphocyte count reverted to normal level in MECG treated mice. From this result it is obvious that the extract has potent dose dependent anticancer activity.

Immunomodulatory effects of Cleome gynandra[9]

Antibody molecules, a product of B lymphocytes and plasma cells, are central to humoral immune responses; IgG and IgM are the major immunoglobulin which are involved in the complement activation, opsonisation and neutralization of toxins etc. Ethanolic extract treated and aqueous extracts of Cleome gynandra statistically significantly decreases the level of serum IgG in comparisons to the level of IgG before the immunization in the trial in rat model. IgG and IgM levels are influenced by both aqueous extract and ethanolic extract but to the different magnitude at different dose levels. Amongst the extracts tested ethanolic extract showed better activity even with lower doses.

The overall pharmacological investigations conclusively demonstrate immunosuppressant activity in the ethanolic extracts and the aqueous extract of Cleome gynandra Linn.

Cell-mediated immunity (CMI) involves effector mechanisms carried out by T lymphocytes and their products (lymphokines). CMI responses are critical to defence against infectious organisms, infection of foreign grafts, tumour immunity and delayed-type hypersensitivity reactions (DTH). Therefore, increase in DTH reaction in rats response to T cell dependent antigen revealed the inhibitory effect of aqueous and ethanolic extracts of Cleome gynandra on T cells. The ethanolic extract of Cleome gynandra (EECG-I) shows better activity i.e. cause 92.74 % inhibition in SRBC (Sheep Red Blood Cell)-induced delayed-type hypersensitivity induced in Albino rat to assess the effect of the fraction on cell-mediated immunity.

Possible antidiabetic drug from Cleome gynandra

In some part of western Orissa the leafs and roots are used by some tribal and traditional healers as an antidiabetic drug. Although the hypoglycaemic properties are not yet studied or proved ,Cleome gynandra is believed to have the efficacy of lowering blood sugar .The possibility of cleome gynandra to use in Diabetes may be reasoned for its anti oxidant properties, Immunomodulatory properties and due to its nutritive value. The glucose oxidation enhancing bioactivity, due to the active phytochemicals are likely to be phenolic in nature also available in Cleome gynandra in plenty. A diabetic complication like Diabetic nephropathy (DN) is a severe and life-threatening complication of long-standing diabetes. As one of the main causes of end-stage renal disease, the prevention and treatment of DN in early stage, and the slowing down of DN progression are of utmost importance and are topics of several ongoing research studies. Nutraceuticals endowed with antioxidant-anti-inflammatory properties may offer an opportunity of integrative treatment for this condition. The multiple plant phytocompounds supplementation does not have any significant affect upon plasma glucose but significantly found to decrease Malonyldialdehyde (MDA) plasma level and the overall redox parameters together with a partial mitigation of proteinuria. Taken altogether, these data show that, besides the mandatory control of glycemia, intervention with a nutraceutical with antioxidant and anti-inflammatory properties may have beneficial effects when integrated in the mainstream of the therapeutic regimen.

Phenolic substances and flavonoids presence in Cleome gynandra have been shown to be

responsible for the antioxidant activity and have been ascribed to various properties like anticancer, antidiabetic,antiaging and prevention of cardiovascular diseases. The crude ethanolic extract and aqueous extracts of Cleome gynandra are a potential source of natural antioxidants like flavonoids. The extraction with non polar to polar solvents in order to obtain highly efficient concentrated antioxidant mixtures. This can be used for further purification and identification of an effective antioxidant compound that can protect from oxidative stress thereby guard the body against various degenerative diseases and also prevent deterioration of food ingredients.

Herbal formulation containing minor and trace elements in bioavailable forms that favourably influences glucose tolerance and possibly increases the body's ability to ameliorate development of diabetes. In previous clinical study and In-vitro experiments it has been confirmed that an Indian herb like Eugenia jambolana enriched in Na, Ca, Mg, Cl, Fe, Cu, Se, and Zn, essential nutrients responsible for curing diabetes[10]

Over the past two decades, an expanding body of evidences from epidemiological and laboratory studies have demonstrated that some edible plants as a whole, or their identified ingredients with potent antioxidant properties, especially the predominant polyphenolics as also in Cleome gynandra, have substantial protective effects on human carcinogenesis, cardiovascular and renal disorders, memory and cognitive function, age-related neurological dysfunction such as Alzheimer's disease, diabetes, ulcers and several other human ailments[11-14].

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