



Review Article

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A REVIEW ON *GOMPHRENA GLOBOSA* (L)

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ABSTRACT

Gomphrena globosa (L.) is commonly referred to as the 'Bachelor's button / Globe Amaranth / kenop flower and has been identified in a variety of traditional medicine systems for the treatment of various human diseases. The plant is native of America, spread widely to Asia. Various biological activities have been reported for *Gomphrena* species. All parts of *Gomphrena globosa* (L.) plant can be used as medicine against various diseases. *G. Globosa* leaves and flower used as a folk remedy, food colorant, oliguria, heat and empacho, hypertension, antioxidant, antimicrobial, cough, diabetes, kidney problems, hoarseness, bronchitis, jaundice and high cholesterol. The present review is to focus on the various extraction, phytochemical evaluation and pharmacological activities of plant *Gomphrena globosa*. Phytochemicals like betacyanin has been reported for significant antioxidant activity as well as anti-inflammatory, anticancer, analgesic, cytotoxic and as natural blood coagulant.

Keywords: *Gomphrena globosa* (L.), extraction methods, betacyanin, pharmacological activities.

INTRODUCTION

Nature is always a golden mark that embodies the excellent symbiosis phenomena. Nature is an eternal source of novel chemotypes and pharmacophores since thousands of years. Number of modern drugs originates from the natural products. In addition, many traditional plants- based medicines play a key role in health care from ancient history to modern times. Natural products always laid the basis for human disease treatment.¹

As a primary health care traditional medicine has been used at the community level by herbalists, healers, spiritualists, hunters and farmers for centuries from ages for their therapeutic potential. They used indigenous plants to treat and prevent diseases and are thought to be the basis of primary health care. Traditional medicines apply familiarity, practices and experience in order to preserve well- being based on the ideas and beliefs of their ethos. Medicinal plants are a major natural alternative to synthetic drugs and the use of native plants in both traditional and modern medicine is attracting considerable attention today.²

As traditional medicine is been used extensively in the modern word as alternate medicines synthetic medicine, the standardization, validation and search for medicinal plants has led to the discovery of new drug candidates for various diseases. According to the World Health Organization (WHO) in 2008, over 80% of the world's population depends on traditional medicine for its primary health needs.³

Countries with highly developed pharmaceutical industries are primarily interested in plants as a source of important biologically active and medicinal compounds that could lead to the discovery of new and better pharmacologically powerful drugs.⁴

Plant derived medicines are based on the premise that they contain natural substances that can promote health, alleviate disease and prove to be safe, better tolerance for patients, relatively cheaper and globally competitive. It is therefore an

absolute requirement to understand healing power of plants and the return to natural remedies.⁵⁻⁶

The Amaranthaceae family (Amaranth family) has many species which have rich lineage in the Caryophyllales flowering plant order. There are about 180 genera and 2,500 species in this family. They are widespread in cosmopolitan to cool temperate regions from tropics.⁷

Taxonomy

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyte
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Caryophyllidae
Order	Caryophyllales
Family	Amaranthaceae
Genus	<i>Gomphrena</i> L
Species	<i>globosa</i> ⁸

The *Gomphrena* genus of the Amaranthaceae family has many representative species around the world. It is commonly referred to as the 'Bachelor's button / Globe Amaranth' and has been recognized in various traditional medicine systems for the treatment of various human ailments.

Gomphrena globosa (Globe amaranth) is a 1- 2 ft (0.3- 0.6-m) annual budding plant with a spread of about 1 ft (0.3 m) tall. The leaves are opposite, oblong, 10- 15 cm in length, clover like flower heads, 3.8 cm in length. The individual flowers in the heads of the flower are inconspicuous, but the stiff, papery bracts that make up the bulk of the structure are colorful and showy in white, pink and purple shades; capsule fruit, oblong, compressed; 2.0-2.4 mm in size. Seeds are ovoid, brown, shiny and almost smooth.⁹

Various varieties of amaranth are available, including: 'Bicolor Rose' has pink and white flowers, 'Buddy Purple' is a short variety with an intensely purple flora (8- 12 "tall), The 'Gnome Series' is available in pink, purple and white and only grows 6" tall, 'QIS Series' offers white, purple, lilac, carmine, rose and red flowers that are particularly good for cutting flora and 'Strawberry Fields' (*Gomphrena haageana*) produces large, brilliant red flowers on 20" plants.¹¹

Gomphrena's biological and medical uses

Gomphrena globosa leaves and flower is a folk remedy for oliguria, heat and empacho, hypertension, antimicrobial, antioxidant, cough, diabetes, hypertension, kidney problems, hoarseness, bronchitis and other respiratory disorders. It has also major cytotoxic and estrogenic activity. The various species of this genus also had antibacterial, anti-malarial and diuretic effects. *Gomphrena globosa* is also commonly used as an ornamental plant. The following biological activities have been reported for the extracts of aerial parts of some species of *Gomphrena* genus.

The plant is used as an abortifacient in South America. *Gomphrena globosa* are applied to the gangrene wound as decoction of the whole plant and a related species. *Gomphrena martiana* and *Gomphrena boliviana* is used by the natives as antimicrobial agents. It is also used as crushed paste of leaves, which is applied to the affected part and covered with the leaves of the same plant, as a treatment for body sore. A number of Brazilian *Gomphrena* species are used as an analgesic, tonic or carminative in the treatment of bronchial asthma and fever. This species exhibits diuretic and anti-malarial activities.

Gomphrena globosa flowers contain betacyanin that are potentially colorful in food and antioxidants. Ethnic tribes, farmers, fishermen and hunters observe small sizes of dark *Gomphrena globosa* leaves to predict the weather forecast indicating adverse weather (typhoon or flood)¹²

Gomphrena species are used in folk for its medicinal and nutritional value in number of diseases including antimicrobial activity, used to treat gastrointestinal and respiratory disorders and infectious diseases. *Gomphrena* species has shown different biological activities as shown in Table 2.

Table 1: Vernacular names

Languages (no. of names)	Vernacular names
English (3):	Globe amaranth, bachelor's button, kenop flowers.
Hindi (1):	Gulemakhamal.
Bangladesh (1):	Botamphul.
Kannada (9):	Adake hoo gida, adike hoo, bilirudrakshi hoo, kaashigonde, kempu gonde, kempu gonge, mahaasahe, nelarudrakshi, rudrakshihoo.
Marathi (3):	Butamy, gomdo, jaapharee
Malayalam (2):	Vadamalli, wadapu
Tamil (15):	Atiyomakaceti, atiyomakam, civappuvatamallikai, kalaimatakkanniceti, kanaiyakanni, kanaiyakanniceti, kurapakam, makacaka, makacakai, makacukkam, vatamalli, vatamallikai, vatanakappu, vatanakappuceti, vatappu
Telugu (4):	Bandu malli, erra pagada banti, rudraakshi, thella pedda goranta.
Manipuri (1):	Chengkruk. ¹⁰

Table 2: Main biological activities Reported for *Gomphrena* species

Species	Biological Activity
<i>Gomphrena globosa</i>	Antimicrobial activity; Anticancer properties; cytotoxic activity; antioxidant activity; anti-inflammatory activity.
<i>Gomphrena celosioides</i>	Antimicrobial activity (Bacteria, <i>Plasmodium falciparum</i>); Anticancer properties; Analgesic activity
<i>Gomphrena boliviana</i>	Antimicrobial activity; Anticancer properties; cytotoxic activity
<i>Gomphrena martiana</i>	Antimicrobial activity; Anticancer properties; cytotoxic activity
<i>Gomphrena haenkeana</i>	Antimicrobial activity; Anticancer properties; cytotoxic activity
<i>Gomphrena macrocephala</i>	Molluscicidal (<i>Biomphalaria glabrata</i>) and cytotoxic against <i>Artemia salina</i>
<i>Gomphrena perennis</i>	Antimicrobial activity; Anticancer properties; cytotoxic activity
<i>Gomphrena meyeniana</i>	Antimicrobial activity; Anticancer properties; cytotoxic activity
<i>Gomphrena pulchella</i>	Antimicrobial activity ¹²

Bioactivity and phytochemical profile comparison of three different globe amaranth cultivars: red, white and pink

The phytochemical profiles and bioactivities of red, white and pink globe amaranth (*Gomphrena haageana* K., *Gomphrena globosa* var. albiflora and *Gomphrena sp.*, respectively) were compared to the purple species (*Gomphrena globosa* L.). The chemical characterization of the samples included macronutrient analysis and individual sugar profiles, organic acids, fatty acids, tocopherols and phenolic compounds. Their bioactivity has been evaluated for antioxidant and anti-inflammatory activities; the absence of cytotoxicity has also been determined.

Samples of red and pink showed the highest sugar content. Otherwise, the white sample showed the highest levels of organic acids and the pink sample showed the highest levels of tocopherol and PUFA. Quercetin-3-O- rutinoside was the main flavonol in white and pink samples, while tetrahydroxy- methylenedioxy

flavone was the main red variety compound that revealed a different phenolic profile.

The pink globe amaranth hydromethanolic extract revealed the highest antioxidant activity, followed by red and white samples. The anti-inflammatory activity in red and pink varieties was more relevant. None of the samples showed toxicity to hepatic cells.

In general, these samples can be used in bioactive formulations against inflammatory processes and in the production of free radicals.¹³

Betacyanin from *Gomphrena globosa* flowers

Betacyanin is natural pigments that have been shown to be antioxidant. Betacyanin has been reported to be able to prevent civilization diseases due to the ability of free radicals to scavenge. Two isomeric pigments assigned to gomphrenin I and

isogomphrenin I was detected in the first fractions. Fractions of large amounts of gomphrenin III and isogomphrenin III have been obtained separately with adequate purity.

The presence of other minor betacyanin of the type gomphrenin was also confirmed as: gomphrenin II, gomphrenin II cis- isomer and sinapoyl- gomphrenin I and their 15S diastereomers. In addition, various unknown pigments were detected in other fractions.¹⁴

Extraction methods

Methods of extraction of whole plant of *Gomphrena globosa*

1. Maceration extraction

The entire plant of *Gomphrena globosa* was washed properly, cut into small pieces and then sun dried for several days. For effective grinding, the pieces were then oven- dried for 24 hours at a considerably low temperature. The pieces were then ground into coarse powder with a high- capacity grinding machine in the laboratory.

5 gm of finely powdered dried plant materials was taken in a beaker and 200 ml of distilled water added. The mixture placed on a hot plate and stirred continuously for 20 minutes at 30°-40°C. The water extract was then filtered by filter paper and the filtrate was used for phytochemical testing. When not in use, the water extract was kept in the refrigerator.¹⁵

2. Solvent extraction

Extracts of crude plants were produced using the Soxhlet extraction method. Approximately 20 g of powdered plant material was uniformly packaged in a thimble and extracted separately with 250 ml ethanol. The extraction process continues for 24 hours or until an extractor's solvent in siphon tube is colorless. The extract was then taken in a beaker and kept hot and heated at 30- 40°C until all the solvent was evaporated, for future use in phytochemical analysis.¹⁶

Methods of extraction of aerial parts of *Gomphrena globosa*

1. Ultrasound assisted extraction (UAE)

The *G. globosa* extract enriched in betacyanin was obtained, working at 500 W, for 22 min, using water as the extraction solvent and a liquid-to solid ratio of 5 g/L.¹⁷

2. Maceration extraction

i) At room temperature, the leaves were dried and then powdered. The powder was exhaustively extracted by maceration at room temperature with 99.8 percent ethanol. The solvent of the ethanol extract was evaporated under reduced pressure to dryness and lyophilized.¹⁸

ii) 500 mg of plant materials have been weighed and macerated in 10 ml 20% trichloroacetic acid pestle and mortar. The homogeneous product was centrifuged at 600 rpm for 15 min. The supernatant was thrown out. 5 ml of 0.1 N NaOH was added to the pellet and centrifuged for 5 min. The supernatant was saved and made up of 0.1 N NaOH up to 10 mL. This extract was used for protein estimation.¹⁹

iii) Five hundred mg of plant materials have been weighed and macerated with 10 ml 80 percent ethanol in pestle and mortar. The homogeneous product was centrifuged at 800 rpm for 10

min. The supernatant had been saved. Ethanol is then evaporated at 500°C in a water bath. The net content was made up to 20 mL with distilled water and the extract was used to estimate sugar reduction.¹⁹

3. Percolation method

Air dried aerial powdered parts of the flowering plants have been extracted in a percolator with methanol.²⁰

Methods of extraction of flowers of *Gomphrena globosa*

Heating under agitation

I. Approximately, 5 grams of flowers were crushed and mixed with 100 mL of solvent (water: methanol (6:4, v/v) or water:acetone (6:4, v/v)), at 37°C, for 30 min under agitation at 900 rpm. The supernatant was subsequently collected, and the procedure was repeated twice. The combined extracts were then filtered, frozen and placed for two days in the lyophilizer. In case of methanol extracts, they were placed at 40°C on a rotary evaporator. The extracts obtained were weighed and re-dissolved at a concentration of 50 mg/mL of the different solvents, covered with aluminum foil and stored under freezing for phytochemical analysis.²¹

Maceration extraction

i) The powdered samples of the pigmented parts selected were extracted at different times (t), temperature (T), water-ethanol ratio (Et) and solid / liquid ratio (S / L) as defined in the RSM design. The solvent volume was set to 20 mL and samples with a fixed agitation speed of 500 rpm with magnetic stirrer were stirred. The mixture was then filtered and centrifuged for 10 min at 14,000 rpm. The pellet was discarded, and the supernatant was gathered carefully and divided into two parts. One part was used to quantify the powder output and light intensity of the extract. The second part of the supernatant was used to measure the total content of betacyanin compounds, reading the spectrophotometer absorbance extract at 530 nm (subtracting the turbidity absorbance obtained at 650 nm); and 2) HPLC-PDA-MS/ESI analysis identifying the individual betacyanin compounds.²²

ii) 100 g of flower powder in 750 ml of methanol was weighed and macerated. The temperature was kept at room for 72 hours. The mixture was mixed with a sterile glass rod for every 24 hours and then filtered by Whatmann Filter Paper. The entire extract was concentrated with a rotary flash evaporator at reduced pressure to dryness. The dried residues of methanol extracts were used for phytochemical analysis.²³

iii) A number of Globe Amaranth dried powder was macerated at room temperature for 24 hours using 96 percent ethanol in a volume of 4000 ml. The obtained macerate was collected and filtered and then concentrated by rotary evaporator in order to obtain thick extract. The extract was then mixed and stored in sealed containers. Petroleum ether, ethyl acetate and n-butanol were mixed with thick extracts. For antimicrobial activity, thick extracts have been tested.²⁴

Solvent extraction

i) In methanolic extract, each sample was extracted by stirring in methanol (25°C at 150 rpm) for 1 hour and then filtered through Whatman No. Four paper. The residue was then extracted by methanol (25°C at 150 rpm) for 1 hour.

Combined methanol extracts were evaporated to dryness at 40°C.²⁵

- ii) 5 g of dried powder of *G. globosa* was extracted satisfactorily in a Soxhlet apparatus with methanol and ethanol, 200 ml each for 8 hours at 45°C. The concentrated ethanol extract was suspended in water and fractionated with butanol (10 × 50 ml) and filtered with Whatman no. 1 filter paper thrice. The solvent was completely removed by distillation at 45° C and the butanol extract volume was reduced to 10 ml by rotary evaporator (45- 50° C).²⁶

Phytochemical constituents of the plant

In *Gomphrena globosa*, at least 27 phytochemicals, including six phenolic acid derivatives and 15 specific flavonoids, have been detected. Flavonoids were the main phenolic compounds found in *Gomphrena globosa* being kaempferol 3-O-rutinoside. Flavonoids include derivatives of quercetin, kaempferol and isorhamnetin.²⁵

Gomphrena globosa ethanol extract phytochemical screening has detected the presence of saponins, alkaloids, sugars and coumarins.¹⁸

The ethanol, petroleum ether, ethyl acetate and n- butanol extract phytochemical screening test from Globe Amaranth resulted in steroids, triterpenoids, flavonoids and essential oil.²⁴

Phytochemicals from leaves and stems

Sterols such as campesterol, β-sitosterol and stigmasterol were identified from the benzene fraction of aerial parts on the chromatograph of the column and TLC monitored the eluates of the columns. Friedelin and epi- friedelinol were produced in the CHCl₃ fraction of aerial parts on the column chromatograph.

Stigmasterol-β-D- glucoside and gomphsterol were found in the n- butanol fraction of the aerial parts on the column chromatograph.²⁰

Phytochemicals from flowers

C₆H₆ and CHCl₃ soluble fractions of the flowers on column chromatograph gave friedelin. Allantoin and chrysoeriol-7-o-β-D- glucoside were found in the n- butanol fraction of the flowers. Four volatile compounds nonanal, decanal, geranyl acetone and 4, 8, 12-tetradecatrilene, 5, 9, 13-trimethyl volatile compounds have been commonly detected in Globe Amaranth floral emits.²⁰

Betacyanin

Betalains are water- soluble pigments that are classified as betacyanin (red- violet) and betaxanthins (yellow). Gomphrenine, isogomphrenin II and isogomphrenin III are the main betacyanins identified in the Globe Amaranth. The other four structural types of betacyanin: betanin, gomphrenin, amaranthine and bougainvillein have been reported.²⁷

Phytochemical evaluation of the aerial parts of flower *Gomphrena globosa* reported that one new triterpenoid saponin (gomphrenoside) and one new hopane derivative (hopone-7β-ol).²⁰

Gomphrenin III was found to be the major betacyanidin found.²⁵ A slightly different profile of flavonol (quercetin, kaempferol and isorhamnetin derivatives) and gomphrenol derivatives as major phenolic compounds in the samples studied and also reported the presence of eight betacyanins, although their profile was different. In addition, higher quantification results for all identified compounds presented more complex betacyanin identification in the *Gomphrena globosa* petals.^{25,29}

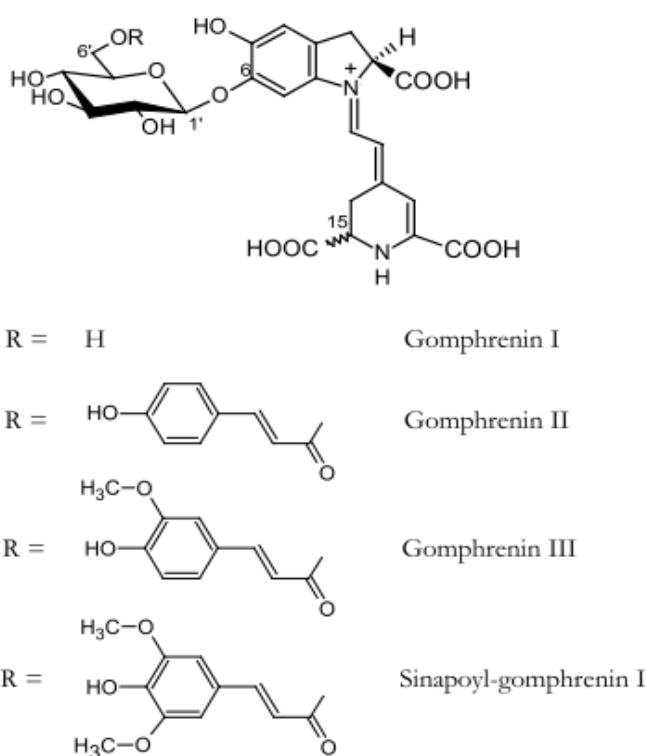


Figure 1: Chemical structures of betacyanins from *Gomphrena globosa* inflorescences

***Gomphrena globosa* Pharmacological Activities**

Antioxidant activity

The antioxidant activity of the *Gomphrena globosa* methanol extract was determined by various *in vitro* models, such as total antioxidant activity, reducing power assay and DPPH radical scavenging activity. The presence of quercetin enhances the effective antioxidant potential of the plant. In comparison with standard ascorbic acid, the plant extract showed the highest antioxidant activity.²³

Antimicrobial activity

Gomphrena globosa antimicrobial activity was determined by the method of agar diffusion using the paper disk by observing the inhibition area. *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Shigella dysenteriae* were condensed with ethanol and n- butanol extracts. The results showed that increased extract concentrations led to a higher bacterial inhibition area. Various partionates of the *Gomphrena globosa* methanol extract have been tested for antifungal activity. A mild to moderate antifungal activity was observed in the carbon tetrachloride soluble and chloroform soluble fraction of methanol.²⁴

Cytotoxic activity

The bioassay for cytotoxicity screening was carried out on brine shrimp lethality. The plant methanol extract n- hexane, carbon tetrachloride and chloroform soluble materials were used against DMSO and vincristine sulfate. In comparison with negative control (DMSO), the positive control was lethal and showed significant mortality in shrimps. Highest lethality of the soluble fraction of chloroform indicates significant cytotoxicity.²⁸

Cardiovascular effects

The mean blood pressure and heart rate were measured in male anesthetized dogs administered with *Gomphrena globosa* ethanol extract. Gg- EE has led to a significant reduction in the blood pressure of the arteries without changes in the heart rate confirming the hypotensive activity of this extract. The hypotensive effect promoted by Gg- EE was significant at 10, 20 and 40 mg / kg doses. A decrease in the efficient discharge of the arterial pressure baroreceptor triggers reflex increases in heart rate, cardiac contractility, vascular resistance and increased venous return. These results are important for the treatment of certain types of arterial hypertension by drugs.²⁴

Anti-cancer activity

Chloroform extract of the aerial parts of *Gomphrena globosa* against carcinoma induced Ehrlich Ascites solid tumor inoculated animals. The anticancer efficacy of *Gomphrena globosa* (CEGG) chloroform extract was compared to 5-fluorouracil. The acceptance criteria for determining a compound's antitumor activity are determining the circulating WBC and lifespan extension. The CEGG significantly reduced the number of WBCs, RBCs, lymphocytes and neutrophils compared with the number of tumors. It is therefore stated that the *Gomphrena globosa* plant is a possible source of the anticancer property.³⁰

Analgesic activity

The analgesic activity of the entire *Gomphrena globosa* plant was investigated for central and peripheral activities by tail- flick and acetic acid writhing test. In comparison to standard diclofenac,

the crude methanolic extract, n- hexane soluble fraction and aqueous soluble fraction at a dose of 400 mg / kg showed significant analgesic activity. These fractions also showed significant central analgesic activity of 400 mg / kg in comparison to the standard morphine.³¹

Anti-inflammatory activity

24 phenolic compounds and 8 betacyanins were determined in three different *Gomphrena globosa* inflorescence extracts. The inflorescences of *Gomphrena globosa* have the potential as a source of anti- inflammatory compounds relevant to the treatment of acute or chronic inflammatory conditions. The decoction of *Gomphrena globosa* purple inflorescence is commonly used in the treatment of several inflammatory respiratory conditions such as bronchial asthma, acute and chronic bronchitis or whooping cough.^{12,29}

Natural Blood Coagulant

The leaves of *G. globosa* act as a natural blood coagulator. It stops bleeding due to cut injury is of immense importance among the ethnic communities. Antioxidant activity, phenol and flavonoid content were investigated for ethanol extract from four medicinal plants *Polygonum microcephalum*, *Moringa oleifera*, *Croton tiglium* and *Gomphrena globosa*. Spectrophotometrically, the total phenol and flavonoid content and DPPH radical scavenging activity of the extracts were determined. The antioxidant activity in *Polygonum microcephalum*, *Moringa oleifera* and *Gomphrena globosa* was found to be higher.³²

Cooling and Cough

Gomphrena flowers are boiled in Trinidad to make a tea that is used for baby gripe, oliguria, cough, diabetes and cooling.¹²

Food Colorant

Fresh crude extract samples *Gomphrena globosa* without any purification was used. Fourteen free and acylated betacyanins, belonging to amaranthin, betanin-type and gomphrenin-type betacyanins, have been identified.¹²

Reproductive Problems

Gomphren globosa is used for reproductive and prostate problems.³³ The root decoction of *Gomphrena demissa* Mart. in a liter of water is used for the treatment of female sterility, amenorrhea, inflammations and ovarian diseases.³⁴

Organic Sulfur Fertilizer

Gomphrena globosa absorbs atmospheric sulfides, which may be of great importance for the improvement of the environment and for agriculture as a green organic sulfur fertilizer used to balance insufficient soil sulfur content for intensive cultivation in China; as a result of rapid industrial and economic development, H S and mainly SO are emitted to air.¹²

Urinary Problems

A non- experimental validation on plants used for urinary problems and diabetes mellitus was performed. The plant *Gomphrena globosa* is used for high blood pressure, which can be safe. Ethno medicinal plants in the Muzaffarnagar district of Uttar Pradesh were surveyed to evaluate the potential of plant resources. The study showed that 15 plant species from 13 families are used in local remedies as anti- urolithic agents. *G.*

celosioides is most efficient and commonly used in urinary tract and kidney stone treatment.¹²

CONCLUSION

Gomphrena globosa is a medicinal plant with countless medicinal qualities for every part that has been used since ancient times. It is effective in treating different diseases. In this review, different extraction methods were attempted for the entire plant, aerial parts and flowers. Traditional uses and pharmacological actions of *Gomphrena globosa* of the plant are reported to have cardiovascular, cytotoxic, antioxidant, anti-inflammatory, antimicrobial, analgesic, antioxidant activity as well as natural blood coagulant, cooling and cough, food colorant, organic fertilizer sulfide, urinary and reproductive problems.

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