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FLOWERS - THE NOBLE ROLE OF THE MOST BEAUTIFUL, PLENTIFUL, BUT NEGLECTED BIO-RESOURCE IN INDIA

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ABSTRACT: The Greek words "angeion" (vessel) and "sperma" (seed) constitute angiosperm which together define enclosed seeds. The angiosperms differ from closely related gymnosperms in seed being naked and not enclosed within a fruit. Moreover, angiosperms are distinguished plants having colorful flowers. Having originated about 130 million years ago, the flowering plants are more diverse and largest among the prominent vegetation. While pteridosperms have been proposed as ancestors of angiosperms, they are the youngest and most recent group of plants having controversies over their origin and are still a hot topic of debate for botanists. Our present investigation is focused on valuing and conserving our beautiful but neglected bioresource that gets blown away or wiped out instead of conservation. From high mountain peaks to sea level and from desert to freshwater, almost all habitats are acquired by flowering plants. The present review signifies the importance of flowering plants in different medicinal aspects. The present literature reveals how researchers have worked on different concepts of flowering plants using petals of flowers as bacterial and fungal proneness is more using leaves, stem and roots The bioactive phytochemicals present in flowers can act as neurotransmitters, hormones, ligands or endogenous metabolites which in turn can be used as plant defense mechanism.

INTRODUCTION: Angiosperms diversity can be explicit as it comprises about 2, 95,383 species (monocots: 74,273, eudicots: 210,008) in 350 families [1]. From duckweed at a size of barely 2mm to Eucalyptus trees at about 100 m, these flowering plants have a remarkable size range. Traditionally, based on the number of cotyledons, they are divided into two groups: the monocotyledons (monocots) and the dicotyledons (dicots) [2].

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Angiosperms are the most plentiful bioresource available and have utmost importance in our food crops. **Fig. 1** shows some angiosperm species which are commonly used for therapeutic purposes. **Table 1** shows the angiosperm plant species along with their status in India and the world. Spanning an area of about 32, 87, 263 kilometers with a coastline of over 7500 km, India is the 7th largest country globally.

From sea level to the high mountain ranges; from hot and dry weather to cold arid conditions; from tropical wet evergreen forests to mangroves of Sundarbans; and from freshwater aquatic systems to marine ecosystems, the ecological or ecosystem diversity of the country is enormous [5]. These varied edaphic, climatic and topographic conditions have resulted in a wide range of ecosystems and habitats such as the Himalayas, Thar Desert, Gangetic plain, Northeast India, Western Ghats, Deccan plateau, Andaman Islands, coastal zone, and Lakshadweep. India has 12 bio-geographical provinces, 5 biomes, and 3 bioregion domains [6] making it one of the 17 mega diversity countries globally, recognized by the World Conservation Monitoring Centre in 2000. Angiosperms are the largest plant group in India, comprising a total of 17,817 species, 296 subspecies, 2215 varieties, 33 subvarieties, and 70 forma, altogether 20,141 taxa of angiosperms under 2991 genera and 251 families. Out of the total recorded plant species of the world the Indian flora accounts for 11.4% and rest 28% of the plant species, are endemic. This huge floral diversity is concentrated in four unique regions of India viz. the Himalayas, Western Ghats, Northeast India, and the Andaman and Nicobar Islands. Dicots account for c. 75% of flowering plants in terms of both genera and species.

On the other hand, the remaining 25% is contributed by monocots [7]. No doubt, India is one of the top-ranked, mega-diverse countries globally. However, in recent years, the alarming rate of loss of biodiversity, particularly ecological, genetic, economic and evolutionary consequences, has become a matter of concern. Threats to species are principally due to decline in the extent of their habitat, fragmentation of habitat, the decline in habitat quality, shrinking genetic diversity; invasive alien species; declining forest resource base; climate change and desertification; overexploitation of resources; the impact of development projects and impact of pollution.

TABLE 1: FLOWERING PLANT STATUS IN WORLD AND INDIA

S. no.	Type	Number of known Species		Percentage of Occurrence in India	Number of Endemic Species	Number of Threatened Species
		World	India			
1	Angiosperms	268600	18043	6.72%	ca. 4036	1700

FIG. 1: SOME COMMON FLOWERS USED TRADITIONALLY FOR VARIOUS THERAPEUTIC PURPOSES

Therapeutic uses of Flowers:

Nanoparticles Synthesis using Flower Extract as a Reducing and Capping agent: Nanoparticles have multifunctional properties and various applications in different fields, such as medication, energy and nutrition. Due to their nano-scale size and huge surface-to-volume proportion, there is an improvement in thermal conductivity, catalytic reactivity, nonlinear optical performance, antibacterial activity, and chemical stability. There is an incredible interest in the utilization of nanoparticles. The nanoparticles that have been synthesized from flower extract till date include almost all sorts of nanoparticles *viz* gold, silver, copper, zinc, titanium, magnesium *etc* [8]. Silver nanoparticles (AgNPs) show an impressively enormous surface region, leading to a significant biochemical reactivity, catalytic action, and atomic behavior compared with large particles with an identical chemical configuration. The formation of silver nanoparticles is a two-step process that first involves the reduction of Ag+ to Ag0 ions and after that agglomeration and stabilization are finished. Then there is the formation of oligomeric clusters of colloidal AgNPs [9]. The findings of studies that have utilized flowers to derive silver nanoparticles have been summarized in **Table 2.** So, the need of the hour is to focus on the differential activity of selective plant parts against tested microorganisms or pathogens at a similar concentration and to draw phytoconstituents to design drugs accordingly, considering such types of observations.

The presence of phenolic and carotenoid pigments and less complex plant metabolites have fascinated the nano researcher to utilize flowers as reducing agents. The literature is scarce on using flowers (*Lonicera japonica*, *Bougainvillea spectabilis*, Daturametel, *Nelumbo nucifera*, and *Ipomoea indica*) as a source for nanoparticle synthesis. Biosynthesis methods are more advantageous than any other classical procedures because of their accessibility to more biological substances and eco-friendly processes [10]. Ancient literature signifies the importance of silver metal used to prevent food spoilage, control bodily infection, and potent wound healer agents. The colloidal silver nanoparticles have been used as antimicrobial agents, wound dressing material, bone and tooth cement, and water purifier [11]. The methods used to synthesize nanoparticles (NPs) are physical, chemical, enzymatic, and biological methods. Plasma arcing, ball milling, pulsed laser desorption, thermal evaporate, spray pyrolysis, ultra-thin films, lithographic techniques, sputter deposition, layer by layer growth, molecular beam epistaxis, and diffusion flame synthesis are means of physical methods for nanoparticles synthesis [12].

TABLE 2: SUMMARY OF FLOWER DERIVED SILVER NANOPARTICLES AND THEIR PHARMACOLOGICAL APPLICATIONS

S. no.	Flower used	Shape	Size (nm)	Peak (nm)	Pharmacological Applications
1	*Tagetes erecta* [17] (Marigold)	Spherical, hexagonal and irregular	10-90	430	Antibacterial activity against *E. coli*, *P. aeruginosa*, *S. aureus* and *B. cereus* Antifungal activity against *C. albicans* and *C. glabrata*
2	*Stenolobium stans* (Yellow bells) [18]	Spherical and cuboid	7.8-4 5.3	455	Nanoparticles can be used for industrial applications
3	*Fritillaria* [19] Drooping Tulip)	Spherical	5-10	430	Highest antibacterial impact on *S. saprophyticus*
4	*T. divaricata* [20] (Crape Jasmine) *P. tuberosa* [20] (Indian kudzu) *C. roseus* [20] (Rose Periwinkle)	Cubic and hexagonal	0.16 9.34 0.21	453 458 468	Antimicrobial analysis Revealed potent activity against *Staphylococcus*, *Salmonella, Aspergillus, Candida and Serratia*
5	*Allamanda cathartica* [21] (Yellow Trumpet)	Spherical	39	350 450	Antioxidant activity and antibacterial activity against *S. typhimurium*, *S. aureus*, *E. coli*, and *K. pneumoniae*
6	*Madhuc alongifolia* (Mahua) [22]	Oval and spherical	30-50	436	Antibacterial activity against *B. cereus* and *S. saprophyticus*, *B. cereus*, *S. typhimurium* and *E. coli*
7	*Chrysanthemum indicum* L. [23] (Indian Chrysanthemum)	Spherical and polydisperse	25–59	430	Larvicidal and pupicidal activity against *A. stephensi*

The chemical methods utilized to synthesize nanoparticles include electro-deposition, sol gel process, chemical solution deposition, chemical vapour deposition, soft chemical method, Langmuir Blodgett method, catalytic route, hydrolysis co-precipitation method, and wet chemical method [13]. Physical and chemical methods use high radiation and highly concentrated reductants and stabilizing agents that are harmful to the environment and human health. The biological synthesis of nanoparticles is a single-step bio-reduction method, and less energy is used to synthesize eco-friendly NPs [14]. The utilization of plant extracts rather than traditional chemical toxic chemicals with the same synthesis procedure of nanoparticles is currently under huge examination [15]. Scientists developed a cheaper and eco-friendly pathway for the generation of nanoparticles by using microbial enzymes and plant extract (phytochemicals). Plant nanoparticles are more advantageous than that of microbial nanoparticles as plant nanoparticles are more stable and take less time to extract metal ions. Moreover, they are not required to be maintained or cultured under aseptic conditions like the microorganism. Also, they can be suitably scaled up for the large-scale production of nanoparticles. The usage of cheap, nontoxic chemicals, eco-friendly solvents, and renewable materials are of great significance in the green synthesis methodology of nanoparticles [16].

A summary of flower-derived metallic nanoparticles has been tabulated in **Table 3**. Flower-mediated green synthesis of nanoparticles may offer important, eco-friendly end products with wide applications.

TABLE 3: SUMMARY OF FLOWER DERIVED METALLIC NANOPARTICLES

Plant (Flower) used	Bimetallic NPs	Shape	Size (nm)	Pharmacological Applications
Crescentia alata [24]	Au-Ag	Spherical	10	High antibacterial and antibiofilm activity
Ocimum basilicum [25]	Au-Ag	Spherical	3-25	Antihyperglycemic, antibacterial activity
Lantana [26] *camara*	Au-Pd	Shape tunable (varyingconc. of metal salt) -Spherical-Hexagonal-Polygonal	5-15, 11-30, 15-40	Remarkably high catalytic activity
Acacia caesia 27	*Ag-Cu*	Spherical	7-14	Good catalytic and electrochemical sensing

Flowers as Essential Oil Bioresource for Food and Drugs: Since a long, essential oils have been widely used in pharmaceutical, sanitary, cosmetic, agricultural, and food industries due to their bactericidal, fungicidal, anti-parasitical, and insecticidal properties. Floral extracts and their isolated essential oils exhibit rich bioactivity due to active phytochemicals or bioactive compounds present in them. Essential oils are considered to possess natural antimicrobial activity, hence finding great applications by the general population and the local industries. They have commercial applications in the bakery, brewery industries, and many more. Essential oils contain a mixture of terpene compounds occurring as diterpenes, triterpenes, tetraterpenes (C_{20}, C_{30}, and C_{40}), and hemiterpenes (C_5) and sesquiterpenes (C_{15}) [28]. The antimicrobial activity of terpenes involves disruption of the cell membrane by their lipophilic constituents. Based on the preliminary phytochemical screening of essential oils extracted from different flowers, the major components are monoterpenes, sesquiterpenes, and their oxygenated derivatives, which contribute substantially to antimicrobial activities [29]. Terpenes are termed terpenoids when they contain additional elements, typically oxygen. Reports have shown bacterial and fungal sensitivity to terpenoids [30].

Extraction Methods of Essential Oils: Essential oils are extracted from plants using hydrodistillation [31], steam distillation [32], headspace analysis [32], solvent extraction [33] and liquid CO_2 extraction [34]. The composition of the extracted oil may vary from one extraction method to another.

A) Hydrodistillation is the simplest and oldest method for obtaining essential oils from flowers. In this method, samples along with water in a distillation unit are brought to a boil by applying mild heat (water distillation); alternatively, live steam is injected into the sample (direct steam distillation). Essential oils are liberated from oil glands present in the flower tissues (due to effects of hot water and steam). On reaching the condenser, the vapour mixture condenses and the distillate flows into a separator, where the essential oil is separated automatically from the distillate water. Laboratory scale isolation of essential oil from flowers has been extracted using hydrodistillation with a Clevenger Apparatus [35].

B) Solvent Extraction: Solvent extraction (solid-liquid extraction) involves the process of leaching. Flower extracts can be prepared either from fresh or dried samples. Before extraction, sample particle size is reduced using air-drying or freeze-drying, followed by grinding, milling, or homogenization.

Various solvents, such as methanol, ethanol, hexane, acetone, ethyl acetate, and chloroform, are commonly used for extraction [36]. The extraction process is repeated 2 or 3 times to ensure maximum extraction and the extracts are pooled together [37].

C) Steam Distillation: Steam distillation is carried out by passing steam into a round-bottomed flask containing the dried or fresh plant material for 90 min and collecting the condensate (water and oil) in a round-bottomed flask. The condensate is extracted three times with ethyl ether to extract the essential oil completely. Sodium Sulfate is added to the ethyl ether to remove moisture. Ethyl ether is then removed by rotary evaporation and the essential oil content is determined on a volume to tissue weight (fresh/dry) basis. Essential oils possess a wide spectrum of antibacterial and antiviral activity. It is observed that essential oil production in flowers is higher than in leaves. Flowers have the most diverse and the highest amount of volatile compounds, components of essential oil [38]. **Table 4** shows some essential oils derived from flowers, their compositions, and their applications. Due to their antimicrobial and antioxidant properties, essential oils have been widely used as flavors and food products for food [39]. The flowers with intense characteristic colors or pleasant aromas may be feasible to be exploited as a food colorant or food fragrance. The traditional uses of flower extracts and their essential oils are natural and safe, with minimal known side effects" on human health [40].

TABLE 4: SOME ESSENTIAL OILS DERIVED FROM FLOWERS, THEIR CONSTITUENTS AND APPLICATIONS

S. no.	Essential Oil	Major Constituent	Potential Activity	Uses
1	*Rosa damascene* (Rose flowers)	Citronellol and geraniol (>55%)	Antibacterial Antioxidant, Antifungal [41,42]	Perfumery and cosmetic industry
2	*Lavandula spp.* (Lavender flowers)	Linalyl acetate (26.32%), linalool (26.12%)	Anti-anxiety effect Anticonvulsant, antifungal [43-47]	Aromatherapy and cosmetics Industry Used during World War I as an antimicrobial agent.
3	*Tanacetum spp.* (Blue Tansy)	Myrcene (13.67 %), camphor (12.67 %), sabinene (9.49 %)	Antimicrobial epileptogenic anti-inflammatory, antiulcer [48,49]	Traditionally used in the manufacturing of cosmetics, insecticides, balsams, medicines, dyes, preservatives and in herbal remedies
4	*Salvia sclarea* (Clary Sage)	Linalyl acetate (52.83%) and linalool (18.18%)	Antibacterial, Antifungal, Anticancer, Antiviral, Antidiabetic, Antimutagenic, Antiprotozoal, Anti-inflammatory, Antioxidant [50]	Used in perfumes and as a muscatel flavoring for vermouths, wines, and liqueurs. It is also used in aromatherapy. Used to induce labour
5	*Syzygium aromaticum* (Clove)	Eugenol (76.8 %), β caryophyllene (17.4 %)	Antibacterial; Antifungal; Anticancer; Antiviral [51, 52]	Analgesic for dental emergencies, Combined with zinc oxide as an analgesic for alveolar osteitis, In aromatherapy
6	*Pelargonium graveolens* (Rose Geranium)	Citronellol (37.5%), geraniol (6.0%)	Antibacterial [53]	Perfume industry, Aromatherapy, Massage therapy, Flavoring agent
7	*Leptospermum scoparium* (Manu ka)	Sesquiterpene hydrocarbons (≥60%)	Antiviral, Antibacterial anti-inflammatory [54, 55]	Used in salves, balms and ointments

Flowers as Alternative Antimicrobial, Anti-oxidant agent: Medicinal plants, especially ayurvedic, having ancient literature of healing and curing, are in demand in many developing countries where buying costly medical health medicines is not a cup of tea for common people. Additionally, they serve as natural remedies to several infectious diseases. Consumption of antibiotics has raised issues with multi-drug-resistant pathogens.

TABLE 5: SOME SELECTED REPORTS ON ANTIMICROBIAL ACTIVITIES OF FLOWER SPECIES

S. no.	Plant No	Methodology	Solvent Used	Activity	Sensitive Microorganisms
1	*Incarville emodi* [56]	Rotary evaporator to evaporate the excess solvent and further processed by lyophilisation.	Methanol and Petroleum ether	Antibacterial and Antifungal activity	Bacteria *S. aureus*, *P. aeruginosa*, *E. faecalis*, *E. coli* Fungi: *C. albicans*, *C. krusei*
2	*Entada abyssinica*, *Terminalia spinosa*, *Ximenia caffra*, *Azadira chtaindica* [57]	Soxhlet extraction for 10 hours or until the extract becomes clear and further dried	Methanol	Antibacterial activity	*C. parapsilosis*, *S. aureus*, *Enterococci*, *P. aeruginosa*, *and Enterobacteriaceae*
3	*Rosa damascena*	Extraction on Ultra Turax mixer, soaked overnight at room temperature and then filtered solution is evaporated under vacuum in a rotavator	Methanol	antifungal activity	*E. aerogenes*, *M. smegmatis*, *E. coli*, *P. aeruginosa*, *A. hydrophila*, *S.enteritidis*, *B. cereus*, *S. aureus*, *S. typhimurium*, *E. faecalis*, *P. fluorescens.*
4	*Cleistocalyx operculatus* (Roxb.) Merr and Perry [59]	Essential oil isolation: hydrodistillation with a modified Clevenger apparatus for 4 h followed by solvent extraction at room temperature	70% Ethanol	Antibacterial activity	Essential oil: *B. subtilis*, *P. aeruginosa*, *S. aureus*, *L. monocytogenes*, *E. aerogenes*, *S. Typhimurium*, *S. enteritidis*, *E. coli*, *S. aureus*, *S. epidermidis*, *E. coli*, *E. faecium*, *A. baumannii*, *E. coli*, *P. aeruginosa*, *S. marcescens*, *S. aureus*
5	Helichrysum gymnocephalum [60]	Solvent extraction at room temperature	Dichloromethane	Antibacterial and Antifungal Activity	Bacteria: *B. cereus*, *E. faecalis*, *S. epidermidis*, *S. aureus*, Methicillin and gentamicin-resistant: *S. aureus*, *E. coli*, *K. pneumoniae*, *P. aeruginosa*, Fungi: *C. neoformans*, *C. Albicans*
6	*Cassia fistula* L [61]	Solvent extraction in soxhlet apparatus	Petroleum ether, chloroform, ethanol, methanol and aqueous solution	Antifungal Activity	*C. albicans*, *C. krusei*, *C. parapsilosis*, *C. tropicalis*
7	*Cassia surattensis* [62]	Solvent extraction at room temperature for 7 days and excess methanol is evaporated by using a rotary evaporator	Methanol	Antifungal, Activity	*Aspergillus niger*
8	*Satureja bachtiarica* [63]	Essential oil isolation: hydrodistillation for 4 h followed by Solvent extraction	80% Ethanol	Antibacterial activity	*E. coli*, *P. aeruginosa*, *K. pneumoniae*, *S. aureus*
9	*Calotropi sprocera* [64]	Solvent extraction in soxhlet apparatus and then ethanol solution is filtered and concentrated under vacuum	70% Ethanol, EtOAc, n-butanol	Antibacterial activity	Ethanol extract : *E. coli*, *K. pneumoniae and S. typhi* n-butanol extract: *S. aureus*, *E. coli and S. typh*
10	*Crocus sativus Linn.* [65]	Maceration for 48 h	Ethyl acetate, ethanol and petroleum ether	Antibacterial and antifungal activity	Ethyl acetate extract: *S. aureus*, *S.epidermidis*, *E. coli*, *M. luteus*, *C. albicans*, *Cladosporium spp.*,

Medicinal plant research has expanded everywhere in the world. The phytochemicals present in plants have shown remarkable antimicrobial properties against these resistant pathogens. Hypersensitivity, immune suppression, and allergic reactions are major side effects observed by the scientific community using commercially available antibiotics.

Phenolics, terpenoids, alkaloids, lectins, and polyacetylene substances act as a defense system of plants against various types of microorganisms and are synthesized and deposited in specific parts or all parts of the plant. Flowers have served as a great contribution to the scientific community. The research articles exploiting flowers as the main ingredient lack mostly observed contamination issues. Other plant parts are prone to the growth of various microorganisms such as bacteria, fungi, viruses, and other microbes. The petal tissues can possess antimicrobial activity and, surprisingly, lack contamination. **Table 5** depicts the examples of flowering plants showing antibacterial activities.

Estimating Antioxidant Content:

DPPH Assay: 2,2-diphenyl-1-picrylhydrazyl (DPPH) is perhaps the most broadly utilized antioxidant assay for plant samples. This free radical is stable at room temperature and reacts with only those compounds that give hydrogen atoms. This technique depends on the reduction of DPPH via the addition of antioxidant molecules or radical species that decolorizes the DPPH solution [66].

β-Carotene Linoleic Acid Bleaching Assay: It is quite possibly the most well-known technique applied to analyze antioxidant activity of examined substances and extracts. β-carotene /linoleic acid emulsion in water with produced peroxyl radicals (LOO•), the principale part of the reaction medium [67]. In this method, the antioxidant property is measured by inhibiting volatile organic compounds and the emergence of conjugated diene hydroperoxides arising from linoleic acid oxidation, which results in the discoloration of beta-carotene.

FRAP: Ferric Reducing antioxidant Potential Assay is a method that depends on the reduction of Fe^{3+} to Fe^{2+} *i.e.*, colorless Ferric complex to blue colored ferrous complex by the activity of electron-donating antioxidants at low pH [68].

Fertility and Antifertility Propensity / Potential of Different Flower Extract: The antifertility agents prevent implantation, ovulation, and fertilization. In males, it prevents spermatogenesis, inhibits testosterone, or affects the gonadotrophin of the organs or the mortality of sperm.

These drugs directly/indirectly affect the menstrual cycle and ovulation in females. Progesterone and Estrogen in the combined form are given as birth control pills. Medicinal plants have been used worldwide to regulate fertility by various tribes and ethnic groups.

The world population is estimated at 7.9 billion. Population control is a significant issue in developing countries. Using medicinal plants as birth control does not have any side effects such as obesity, thromboembolism, and carcinogenic effects posed by chemical, hormonal, or immunological methods.

Ethnobotanical surveys of fertility agents extracted from flowers used among many tribes have been reported. Many flowers in different formulations have been used in Unani, Ayurvedic, and Siddha systems of medicines to treat gynecology diseases or used as aphrodisiacs. A brief description of these flowers and their major constituents and therapeutic uses have been tabulated in **Table 6**.

Many flowers have exhibited antifertility activity in clinical trials. Antifertility plants are the drugs that obstruct the formation of gametes and interfere with the process of fertilization. Antiovulatory plants act by suppressing ovulation. These drugs are injected or taken orally.

Anti-implantation plants prevent the attachment or penetration of fertilized ovum into the uterus. Abortifacient plants cause early expulsion of fetuses [71].

Literature study revealed that there are many flowers used for fertility regulation with their efficiency proven in clinical trials. **Table 7** discusses such flowers along with the animal model, extract used and their mechanism of action.

TABLE 6: FLOWER EXTRACTS USED IN THE TRADITIONAL SYSTEMS OF MEDICINE AS FERTILITY REGULATORS [69, 70]

S. no.	Flowers	Flower Description	Major Constituents	System of Medicine	Uses
1	*Abutilon indicum* (L.) Sweet Family: Malvaceae	Yellow and Solitary	Luteolin, chrysoeriol, luteolin 7-O-β-glucopyranoside, Chrysoeriol 7-O-β-glucopyranoside, apigenin 7-O-β-glucopyranoside, Quercetin 3-O-β-glucopyranoside, Quercetin 3-O-α-glucopyranoside	Siddha system	Aphrodisiac
2	*Crocus sativus* L. Family: Iridaceae	Solitary or clustered, narrowly sessile, stamens 3 eared, basifixed blue, scented, appearing with leaves, throat of perianth bearded, anthers yellow	Safranal, saffron, picrocrocin, crocin-digentiobioside of crocetin, carotenes (α & β), lycopene, zeaxanthin, proteins, starch and crude fibre	Ayurvedic System	Dried stigmas useful in sexual debility
3	*Eriodendron pentandra* (L.) Kurz. Family: Bombacaceae	Rose or dark red with large lowers	Cyanogenic Glycosides, alkaloids tannins, flavonoids, saponins, sterols	Siddha system	Flowers mixed with cow's milk is used to increase the sperm count
4	*Erythrinavarie gata* L. Family: Fabaceae	Large, coral red in dense racemes	Erythrosine, ferulic and caffeic acids, rutin, quercetin	Siddha system	Antidote to sterility
5	*Hibiscus mutabilis* L. Family: Malvaceae	White/ pink	Quercimeritrin meatrin and cyanin	Siddha system	Sterility and Aphrodisiac
6	*Hibiscus rosasinensis* L. Family: Malvaceae	Red, yellow or white	Anthocyanin pigment, cyanidindiglucoside	Ayurvedic System	Used as contraceptive
7	*Hybanthus Enneaspermus* (L.) F. V. Muell. Family: Violaceae	Pink, solitary, axillary, spurred, pedicels long	Flavonoids, phenolic acids and tannins	Siddha system	Increasing libido and improving the quality of semen
8	*Madhuca Longifolia* (Koen.) Macbr Family: Sapotaceae	Pale yellow and fleshy appear in dense clusters near the ends of branches, corolla tubular, fleshy pale yellow, aromatic and caduceus	Glucose, invert sugar, cellulose, albuminosides	Ayurvedic System Siddha System	Sexual debility Aphrodisiac
9	*Mesua ferrea* L. Family: Clusiaceae	Fragrant, cream coloured, ebracteate, pedicellate, pedicel short, axillary or terminal, solitaryor inpairs(cluster), large, bisexual and sub-sessile	Glycosides, coumarins, flavonoids, xanthones, resins, triglycerides and essential oils like α-copaene, germacrene D	Unani System Ayurvedic System	Sexual Debility Aphrodisiac
10	*Mimus opselengi* L Family: Sapotaceae	White, fragrant 2.5cm wide, solitary or in clusters of 2- 6.	D-mannitol, β-sitosterol, quercitol, dihydroquercetin, α-spinasterol, ursolic acid, lupeol, fatty oils comprising capric, lauric, myristic, palmitic, stearic arachidic, oleic and linoleic acid	Unani System	Premature ejaculation, Sexual Debility Excessive nocturnal emission
11	NelumbonuciferaGaertn. Family: Nelumbonaceae	White or pink, solitary, large	Lupeol, alpha amyrin, lysine, alpha-sitosterol, n triacontanol, amino acids	Ayurvedic System Siddha System	Sterility Aphrodisiac

TABLE 7: FLOWERS WITH PROVEN EFFICACY AS FERTILITY REGULATORS IN CLINICAL TRIALS

S. no.	Flower	Animal model	Extract used	Mechanism of action
1	*Achillea millefolium* [71]	Swiss mice	Ethanolic and hydroalcoholic extract	Antispermatogenic effect
2	*Azadira chtaindica* [73]	Sprague-Dawle y rats	Alcoholic extract	Disrupted the estrous cycle
3	*Calotropis procera* [74]	Mature male swiss albino mice	Aqueous and Ethanolic Extract	Antispermatogenic activity
4	*Hibiscus rosa-sinensis* [75, 76]	Female albino rats Adult male albino mice	Total benzene extract Benzene, chloroform and alcoholic extracts	Anti-implantation activity Antispermatogenic Activity
5	*Justicia simplex* D. Don [77]		MeOH	Sperm Acrosomalmembrane stabilizing action
6	*Malvaviscus conzatti* [78]	Cycling unilaterally Ovariectomized (ULO) rats	Methanol extract	Antiovulatory
7	*Piper longum* [79]	Rat	Piperine	Antispermatogenic effect
8	*Striga senegalensis* [80]	Female albino rats	Ethanol extract	Anti implantation activity
9	*Tabernaemontana divaricata* [81]	Female Wistar rats	Methanolic and aqueous flower extract	Estrogenic, anti-implantation and early abortifacient activity

Literature is studied with research articles of exploiting floral extracts as alternative fertility/antifertility agents. Herbal antifertility agents (oral contraceptives) are preferred for being economical with minimum side effects. Recently efforts are being made to explore the hidden wealth of flowers for contraceptive use. Herbal medicine remains one of the common forms of therapy available to much of the world's population to maintain health and treat diseases. The folklore information and the ancient literature about flowers and petals can help the antifertility program and accumulate information regarding the screening of plants having antifertility efficacy.

CONCLUSION: Flowers are considered the most beautiful and plentiful resource available to any country and have immense potential in the food, pharmaceutical, and health sectors due to their antimicrobial and antioxidant properties. Nanoparticle synthesis from flower extract can be used for their remarkable antibacterial, catalytic and diagnostic applications. Flower-derived essential oils exhibit antibacterial, antioxidant activities with broad-spectrum and can serve in curing many ailments related to skin and hair and being natural and having no side effects. Cosmetic and the food industry cannot survive without flowers and must contribute to the seasonal collection of flowers that get blown away. The drugs elicited from floral extracts have no or very little side effects as compared to chemically prepared drugs. Flowers have also been proven to show fertility regulation potential.

In addition to the economic and commercial benefits of flowers, they are also aesthetically pleasing and soothing. Research shows that being around flowers increases general well-being, calms the mind, increases concentration, and helps relax. Therefore, the economic importance of flowers is indisputable. Secondary metabolites are the main key elements in capping and reduction of metallic ions in the green route synthesis of nanoparticles. The plant-mediated nanoparticles have the potential to be used in various fields such as pharmaceuticals, therapeutics, and other commercial products.

Flower-derived nanoparticles show good insecticidal activities and can be used in different applications. This report reviews the use of various flower extracts in nanoparticles synthesis, antimicrobial, antioxidant activity, and essential oils extracted from flowers. For development in the health sector, we need to conserve the ample floral bioresources and avoid exploiting essential parts like fruits and leaves. The genetic diversity of any country is its brand value. To preserve the same, Indian researchers need to find alternative sources, and floral diversity is among the most plentiful resources which can be put to use.

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