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A review on ethnomedicinal properties on polianthestuberosa L.

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***Abstract*---**Flowers are a key source of released fragrance volatiles in the biotic world. Despite the fact that volatile organic compounds (VOCs) have low molecular weights, low polarity, and low vapour pressures, the process of volatile release is influenced by the floral tissue's morphology, anatomy, and cellular properties. Polianthestuberosa L. is a flowering plant in the Agavaceae family (also known as Asparagaceae and Amaryllidaceae by some botanists) that is commonly seen in Bangladeshi gardens. In India, tuberose is commonly known as Gulchari and Galshabbo in Hindi, Rajanigandha in Bengali, Sukandaraji and Nelasanpengi in Telugu, NilaSampangi in Tamil and Sugandharaja in Kannada. Commercially, the plant is grown for its aromatic blossoms. The plant is used for a variety of folk medicinalpurposes, including tumour, cosmetic, laxative, cooling, placebo, sexual disturbance, hair colour, emetic, diuretic, and gonorrhoea. The plant includes a number of flavonoids and other polyphenols that may be useful in the treatment of a variety of diseases associated with or caused by oxidative stress, such as diabetes, rheumatoid arthritis, and cardiovascular problems. Pharmacological studies indicate that the plant has antimicrobial, anti-oxidant, anti-viral, immunomodulatory, diabetic wound healing, anti-inflammatory, anti-amebic, anti-ulcer, and neuro-pharmacological properties. The existence of bioactive principles, as well as the plant's historic usage and documented pharmacological qualities, suggest that it could be a valuable source of lead

compounds and novel medications. In this review article; the present aim is to study the information about the plant including its taxonomy, morphological characters, ethnobotanical uses, propagation & cultivation, reported phytochemical constituents and pharmacological activities.

Keywords---polianthes tuberosa, taxonomy, morphological characters, ethnobotanical uses, propagation, cultivation, phytochemical constituents, pharmacological activities.

Introduction

There is always a demand for new and novel varieties in the floriculture sector. The key novelty identifiers in the world wide flower industry are the flower's colour, form, and perfume. In breeding, genetic variety is critical. *Polianthes tuberosa* is used for cut flower production, floriculture, and oil production all over the world. In India, breeding has produced high- yielding cultivars, but no new colour has been generated. According to a literature review, creating genetic variety through Conscious/Selective breeding can result in the formation of coloured tuberose. In India, Several flowers are grown for example tuberose, jasmine, marigold, chrysanthemum, crossandra, aster, rose, carnation, gerbera, gladiolus etc. During the year, 2010-11 the total area under floriculture production in India was 253.65 thousand hectares with a production of 1.652 million tonnes loose flowers and 750.66 million cut flowers[1].The most significant phase in producing new flower colour tuberose through hybridization and in-vitro mutagenesis is the collection of coloured germplasm.

For a modern science-based and industrialized floriculture there is always demand and necessity for new varieties. Global flower industry thrives on novelty traits such as flower colour, form and scent which are primary novelty markers and key determinants in consumer choice. At present, the total area under tuberose cultivation in the country is estimate to be about 20,000 hectares[2]. Ornamental species fall into two main categories. The first group of plants are capable of sexual reproduction, but are propagated vegetatively for commercial purpose. The second group are apomicts. Hybridization fails to produce any variety in obligatory apomicts. The present-day colourful ornamentals have evolved through complex inter-specific crosses among elemental species, open pollination, indiscriminate intervarietal hybridization, spontaneous and induced mutation, selection and management of chimera. Creation of genetic variability is a prerequisite for development of new varieties.

Genetic diversity plays an important role inbreeding because hybrids between genetically diverse parents manifest greater heterosis than those between closely related parents. It is important to understand the science behind flower colour inheritance, polyploidy, and potential sterility of one or more parents before hybridization. It has a greateconomic potential for cut-flower trade and essential oil industry[3]. It's not always easy to achieve a hybridizer's goal, but by understanding some of the genetics at play, one may make better selections about which crosses are likely to succeed. Normally for developing new variety through

hybridization in any ornamental crop, we start crossing among varieties/species available at hand. The cross may be a success or not. If it is a success, the seedlings from the segregations are established and a new variety is claimed. But this variety may not have any/much market value. Hence scientific manpower and time are wasted. As a result, before we begin hybridization, we must first gain relevant knowledge.

For crop improvement and more specifically development of new varieties, a number of plant breeding methods like cross-breeding, induced mutagenesis and molecular breeding are available .Plant breeders have used traditional genetic approaches to creat a wide range of blooms. However, because of restrictions in any one species gene pool, some colours are still underrepresented in many attractive plant species. The final visible colour depends on a number of factors like type of anthocyanin accumulation, modifications to the anthocyanin molecule, co-pigmentation and vacuolarpH. A number of genes influence each of these parameters. Basic genetic information must be gained by study of breeding systems and experimental hybridization incorporating both cultivated and elemental species from the wild in order to carry out a relevant improvement programme. The long spikes of flowers are excellent for cut flowers and people like their sweet fragrance[4]. Information generated by such studies has helped in the circumscription of 'gene pools' and their utilization in the creation of new and novel cultivars of commercial importance keeping in view the direction of market trend. An understanding of the breeding and genetic system of a plant is important because these control its heredity and variation. Polianthes tuberosa L. (Amaryllidaceae) is an ornamental plant, cultivated in china, Egypt, South Africa, India and Japan for its fragrant cut flowers and perfume industries[5,6]. To develop new ornamental plants, breeders should learn about the fundamental techniques used in plant breeding, ranging from classical plant breeding (e.g. recurrent selection, inbred line extraction, backcrossing, hybrid varieties, and mutagenesis) to modern molecular tools (e.g. marker assisted selection and genetic modified crops).

Tuberose (Polianthestuberosa) is a perennial agave plant belonging to the Agavaceae family, whose extracts are utilised as a middle note in perfumery[7]. In relation to its root system, the common name tuberosa comes from the Latin tuberosa, which means bloated or tuberous. It has roughly 12 different species. Polianthesin greek is for "grey blossom" The tuberose, like all other Polianthes species, is a night- blooming plant that is assumed to be native to México. It is a well-known plant in indian mythology and culture[8].Wedding ceremonies, garlands, adornment, and numerous traditional rites all employ flowers. Perfume is made from the oil taken from the flower. It has a complex, exotic, sweet and floral aroma. The tuberose grows in elongated spikes up to 45 cm (18 inch) long, and produces clusters of fragrant waxy white flowers that bloom from the bottom towards the top of the spike. Long, bright green leaves cluster at the plant's base, with smaller, clasping leaves throughout the stem [9]. It thrives in sunny spots and blooms in late summer and its tall stems and rather sparse, grass-like foliage make them ideal for inter-planting [10].Tuberoses refer to members of then early related genus Manfreda.

Plant tissue culture techniques are used to propagate plants under sterile circumstances, often to grow clones of a plant, which rely on the ability of numerous plant cells to regenerate a whole plant.to regenerate a whole plant. Single cells, plant cells without cell walls (protoplasts), pieces of leaves, roots, or rhizomes can often be nutrients and plant hormones [11].

In the culturing of plant cells, plant growth regulators are used to produce callus growth, multiplication and rooting. Benzylaminopurine (BAP) is thought to be more significant than other plant growth hormones investigated so far for in-vitro propagation of these plants using tissue culture techniques. Plant tissue culture has recently been applied to the generation of economically useful compounds [12]. The main chemical compounds are methyl benzoate, methyl anthranilate, benzyl alcohol, butyric acid, eugenol, nerol, farnesoland geraniol. This study used several combinations and concentrations of naphthalene acetic acid (NAA), BAP, and other growth regulators in MS media to propagate the tuberose plant, P.tuberosa L., in-vitro [13]. Tuberose is a highly rare and distinctive bloom with a lot of commercial potential in the cut flower and essential oil industries. Tuberose spikes are used as cut flowers in bouquets and vase decoration, while individual flowers(florets) are used to make venis, gajaras, garlands, floral ornaments and buttonholes, as well as extracting essential oils for the perfumery and cosmetic industries.

Tuberose is mostly grown commercially in West Bengal, Karnataka, Tamil Nadu, Maharashtra, and Andhra Pradesh in India. Due to its ease of cultivation, minimal input, wide adaptability, multipurpose usage, and better return, it is gaining popularity in India. This traditional Indian flower crop blooms all year long. Tuberose is a perennial bulbous plant that is partly hardy. Bulbs are made of scales and leaf bases and stems remain concealed within scales [14]. Roots are adventitious and shallow. Leaves are linear, long, grass like foliage and bright green. Tuberose spikes have florets in pairs that unfold acropetally (i.e., from base to top of the spike). Tuberose is a cross pollinated crop. Flowers have funnelled perianth and are fragrant, waxy white, about 25 mm long. Stamens are 6 in number, ovary 3 ocular, ovules numerous and fruits are capsule There are 4 types of tuberose named on the basis of the number of rows of petals they bear. They are Single, Semi-double, Double and Variegated. Because the konkan region's agro climatic conditions and soils are conducive to commercial tuberose growth, it has the potential to become a commercial flower crop in the future. commercial flower crop in the future. In Konkan region major cities like Mumbai, Thane, Palghar and God are major markets for flowers. In this regard, efforts were made to identify a suitable tuberose variety for commercial cultivation in the Konkan agro-climatic conditions [15].

Plant Profile

Figure 1. Plant profile of *Polianthestuberosa*

Taxonomic hierarchy of *Polianthestuberosa* [16]

Table 1
Taxonomic hierarchy of *Polianthes tuberosa*

Kingdom	Plantae
Sub-kingdom	Tracheobionta
Division	Magnoliophyta
Class	Liliopsida
Sub-class	Liliidae
Order	Liliales
Family	Agavaceae
Genus	Polianthes
Species	Tuberosa
Scientific Name	*Polianthes tuberosa* L.

Tuberose is growing in various countries such as India, China, Bangladesh, Mexico, Kenya, Italy, France, Morocco, USA, Hawaii and South Africa. Tuberose is grown commercially in India in West Bengal, Karnataka, Tamil Nadu, Maharashtra, Uttar Pradesh, and the North Eastern states.

Morphology of tuberose

- Tuberose is a bulbous, half-hardy perennial plant that reproduces through bulb (25-30gm weight and2-3cm diameter) and bulb lets (1-1.5cm diameter).
- The stem is a condensed structure that remains hidden within scales, while bulbs are made up of small scales and leaf bases.
- Adventitious and shallow roots mainly found in tuberose.
- Long, slender, linear, grass-like, light green leaves appear in a rosette.

- Tuberose blossoms are funnel-shaped, with a highly scented perianth and waxy white flowers that are single or double and borne in a spike single or double and borne in a spike.
- Number of stamens are six, anthers dorsifixed in the middle, ovary 3 ocular, ovules numerous and fruit type are capsule [17].

Cultivation and collection of tuberosa

Tuberose has around fifteen species under the genus of Polianthes, but twelve species are distributed from Mexico. Among these flowers nine species have white, one is white tinged withred and two are red. Only Polianthestuberosa L. is grown commercially, with the rest flourishing in the wild. Tuberose species are listed below in various categories.

Polianthes tuberosa

It is an erect herb, 70-130 cm high with stout and short bulbs; leaves basal, 8 to 10 in number, 30-50 cm long, about 1.5 cm wide, linear, flowers star shaped, waxy white, tube bent only near the base, filaments attached on upper part of corolla, fragrant in long terminal racemes, bright green, reddish near the base, flowers star shaped, waxy white, tube bent only near the base, filaments attached on upper part of corolla, fragrant in long terminal racemes [17,18].

Soil and Climate Requirement

- **Soil:** Tuberose may grow in a variety of soils; however sandy-loam and loam soils are excellent. For high-quality flower production, the soil should have sufficient aeration and drainage, as well as a PH of (6.5-7.5) [19]. It can also be successfully grown as a commercial crop even in those soils which are affected by salinity and alkalinity conditions if better agronomic practices are adopted.
- **Climate:** Tuberose grows well in tropical, subtropical, and temperate areas, however it prefers to be in the open and sunlight. In India, the commercial cultivation of tuberose is mainly confined in warm humid areas with average temperature range from 200C to 350C. It demands high humidity and a temperature of roughly 300C for lush development, while temperatures exceeding 400C diminish spike length and bloom quality. Plants and flowers are also harmed by extremely cold temperatures and frost.

Cultural Practices

- **Site selection:** Tuberose is a sun-loving plant that requires plenty of light for optimal vegetative growth and flower production. The location should be chosen such that the plants receive adequate sunlight throughout theirgrowing season. The soil should have sufficient moisture holding capacity but not water logging conditions. This field should be away from shade because shade condition plants showed lanky growth.
- **Land preparation:** Land preparation is very important for the cultivation of tuberose. The field should be worked deep to a good plough and properly manure. If the soil is not thoroughly prepared and contains soil clods or un-decomposed organic matter, bulb production is highly affected and it also

reduces the yield and quality of flowers. Well rotted cow dung or farmyard manure (50-60) tonnes/ha, should be incorporated with the soil about a month before planting. Weeds should be removed from the land with care.

- **Seed or bulb treatment:** Before sowing the bulb should be treated with GA3 or Thiourea for breaking the dormancy and easily sprouting. Pre-plant bulbs should be stored at (8-10) °C for one month to improve plant growth, increase spike and flower yield. Bulbs should be stored at 10℃ for 30 days before planting to promote plant development, spike and bloom output. Before planting bulbs treated with GA3, ethereal or thiourea promotes early appearance of flower spike and produces longer spikes with maximum number of florets. At first Bulbs were totally cleaned after being treated with Bavistin (0.2%) for 30minutes to reduce fungal infection. Dry in shade before planting or storing. Before planting treat bulbs in systemic fungicide and before storing in contact fungicide [17,18,20].

Propagation of tuberose

Tuberose is commercially propagated via Vegetative means (bulb, bulblet, and bulb division), however seed propagation is uncommon due to the difficulty of seed multiplication. Nowadays tuberose is also propagated by tissue culture to get virus-free planting material production.

Seed Propagation

Tuberose seed set is recorded in favourable environmental conditions, but only for a particular cultivar. Seeds are sown in a well prepared growing medium containing leaf mould, Vermicompost and garden soil in equal proportion under portrays nursery. Moisture and temperature have a marked effect on germination. Ideal soil temperature of 25°C is fully effective for increased seed germination. Before transplanting the bed should be prepared by digging and sufficient quantity of FYM is to be mixed before sowing. The seedling is sown in rows 10-12 cm apart and 5cm deep in heavy soil and 2.0 cm in light soil [17,18,20,21].

Vegetative Propagation

- **Propagation by Bulb:** Most common method practiced for the commercial multiplication of tuberoses is through propagation by bulbs. In regions where the temperature is low, the bulbs remain dormant during the winter months. If early planting is desired, the dormancy of the bulbs can be successfully broken by treating the bulbs with a 4 % thiourea solution for one hour. Ethylene chlorohydrins can also be used to break the dormancy of bulbs. Before sowing, the scale should be removed from the bulb so that it easily sprouts. Selection of ideal size bulbs is very important for quality production. In general, spindle shaped bulbs free from diseases having diameter between 2.0 cm to 3.0 cm are suitable for planting. About 1.30-1.60 lakh bulbs (10-12 tons of bulbs) are required for planting one hectare.
- **Propagation by division:** Other propagation method of tuberose is division of bulb. Sprouting is dependent on bulb size, and only large bulb segments (2cm or more in diameter) regenerate successfully [22]. Bulbs normally cut into 2-3 vertical sections, each segment must contain buds and a part of the basal

plate. Each of these sections is fungicide-treated and vertically planted in a rooting media, with just the tips visible above the surface. The basal plate produces new bulblets as well as roots. At this time they are transferred to the ground to continue growth [17,18,20,21,23].

- **Micro-propagation of tuberose:** It is yet another high-tech way for producing high-quality planting materials. The main focus of micro-propagation is free from nematode affected planting material production.
- **Spacing, Depth and time of sowing time of tuberosa:** Planting density has a significant impact on flower yield and quality. It depends upon soil, bulb size and climatic condition. High and low both planting density adversely affected quality flowers production. For economic returns, bulbs are planted at an optimum spacing of 30x 20cm or 20 x 20 cm [24] or 30 x 30 cm with 5.0 to 7.0 cm depth. But, depth also depends upon size of bulbs (large bulb more depth and small bulb less depth)[25]. About 45,000-55,000 bulbs are required for one acre planting of tuberosa. Tuberose is generally planted in January-March in the plains and in April-May in the hills. On medium fertile clay soil, the best time for planting is during June month. In southern parts of India, the bulb should be planted in the month of July-August. The largest output of spikes and blooms has been observed when bulbs are planted in April.
- **Nutrient Management:** Organic manure has a vital role for quality flowers production but, organic manure is unable to fulfill the demand of plant nourishment. So, in-organic fertilizer must be applying for proper growth and development but as a suitable dose. High dose of N and P markedly promotes leaf and bulb formation [26] but on the other hand, excess N as the flower spike becomes The plant become more susceptible to illnesses and pests as they grow taller and softer, rendering them sensitive to wind. FYM(20tonnes/ha) fertiliser doses are ideal for tuberose cultivation, with 120kg N, 60kg P205, and 80kg K 20 Per hectare recommended. The dose should apply half of the nitrogen, the entire dose of P and K should be applied at the time of planting, and the remaining half of the nitrogen should be applied in two split doses 30 and60 days after sowing.
- **Water Management:** Water management has a vital role in the quality production of flowers. It depends upon soil type, environment condition and cultivar. Optimum amount irrigation should be applied before sowing so that better sprouting and further irrigation should be avoided until the bulbs have sprouted. Too much moisture in the soil at the time of sprouting results in the rotting of bulbs and similar conditions during flowering adversely affects the development of spikes and flowers. The tuberose fields should be irrigated at intervals of 10-15 days, if the weather is dry (www.agritech.tnau.ac.in). It has been suggested that during summer months (April to June) the crop should be irrigated at weekly intervals and during winter at 10 days intervals.
- **Harvesting:** It is a very important cultural technique among the other cultural techniques. It should be done within a proper time and proper stage, otherwise economic loss is high. Flowering of tuberose starts 3 to 4 months after planting and flowering time is July but August-September is the peak period of flowering. Tuberose is grown all year and harvested according to the purpose and distance from the market. Tuberose should be collected after the lowest pair of flowers has fully opened in a nearby market and when the lower

flower buds have just burst in a distant market [27], but ideal harvesting time in the morning or evening by a sharp knife. Tuberose bulbs must be harvested at the appropriate maturity level in order to be stored and flourish. When the flowering is over and the plant stops growing, the bulbs achieve maturity. Before digging up the bulbs, the old leaves should be completely dried. The leaves are chopped at ground level, and the bulbs are removed from the soil [17,18,20,21,23,28].

- **Yield:** Flower production always depends upon varying bulb size, planting time and density of plants. In roughly3 to 4 months after planting, the flowers are ready to harvest. 4-5 lakhs/ha spikes production (cut flowers) and 7-10 ton/ha flowers production (loose flowers) in the first year; 5-6 lakhs/ha spikes production (cut flower) and 10-13 ton/ha flowers production in the second and third years (loose flowers purpose). In addition, 25-30 tonnes/ha of bulbs and bulblets may be harvested at the end of 3rd year.
- **Post-harvest handling and packaging:** Loose flowers are packed in bamboo baskets holding about 10-15 kg flowers and are transported to the local market where they are sold by weight. Grading should be done for cut flower purposes and it depends upon colour, number of florets, length of the spike, injury of the spike, weight of spikes and then bunched in round bundles in circular bundles of around 100sticks apiece. Wet newsprint sheets are wrapped around the stems of the bundles. To avoid damage to the flowers and buds, the whole bundle should be wrapped in soft, white tissue paper or polythene. Before packed spike should be dipping pulsing solution containing 200 ppm silver nitrate (AgNO3) and4mMsilverthiosulfateSTS [29]. or solution containing sucrose2%+8HQC(200ppm)+ AgNO3 (50 ppm) for increased shelf-life [30] and later bundles packed in the card-board boxes and shipped by air to reach the destination quickly.
- **Storage of Bulbs:** The soil adhered to the clumps are removed and the offshoot is separated by rubbing off. Bulbs are graded into different groups based on the size of the bulbs diameter. Loose scales and long roots should be removed, and bulbs are graded into different groups based on the size of the bulbs diameter. They're kept separate in a cold, dry, and shady location. To avoid and control the spread of mold and rot during storage, the bulbs should be stirred every few days. Storage for 5-6 weeks is necessary before the bulbs are ready for planting [17,18,20,21,23,28,31].

Reported phytochemicals constituents

- From the **aerial parts of the plant**, a new bisdesmosidiccholestane glycoside has been isolated along with three new spirostanol saponins and a cholestane glycoside [32]. Three glycosides and a long chain alcohol has been isolated from the bulbs of the plant, which were identified as 3, 29-dihydroxy stigmast-5-ene-3-O--D-galactopyranoside, ethyl--D-galactopyranoside, ethyl--D-galactopyranoside, and1-tricosanol [33].
- From **underground parts of the plant** resulted in isolation of four new spirostanol saponins with five monosaccharides [34]. Six new steroid glycosides – two spirostanols, polianthosides Band C, and four furostanolic, polianthosides D-G has been isolated from fresh tubers of the plant together with seven known spiro stanols and a known furostanol saponins[35].

- The **leaves part of plant** have further been reported to contain a butyrolactone and three flavonoids (kaempferol, kaempferol-3-O-xyloside and kaempferol-3-4'-O-dixyloside), 9,10dehydro hecogenin-3-Glucose xylose galactoside, kaempferol-3-O-xyloside, alphaD-glucoside and polianthosides B and C [36].
- Form **whole plant extract**, mild antifungal activity has been reported like strong antifungal activity has been demonstrated by three phytochemicals constituents present–geraniol, indole, and methyl anthranilate against the mycelial growth of Colletotrichumgloeosporioides on potato dextrose-agar medium [37]. The structures of some of the phytochemicals are shown in Figure 02.

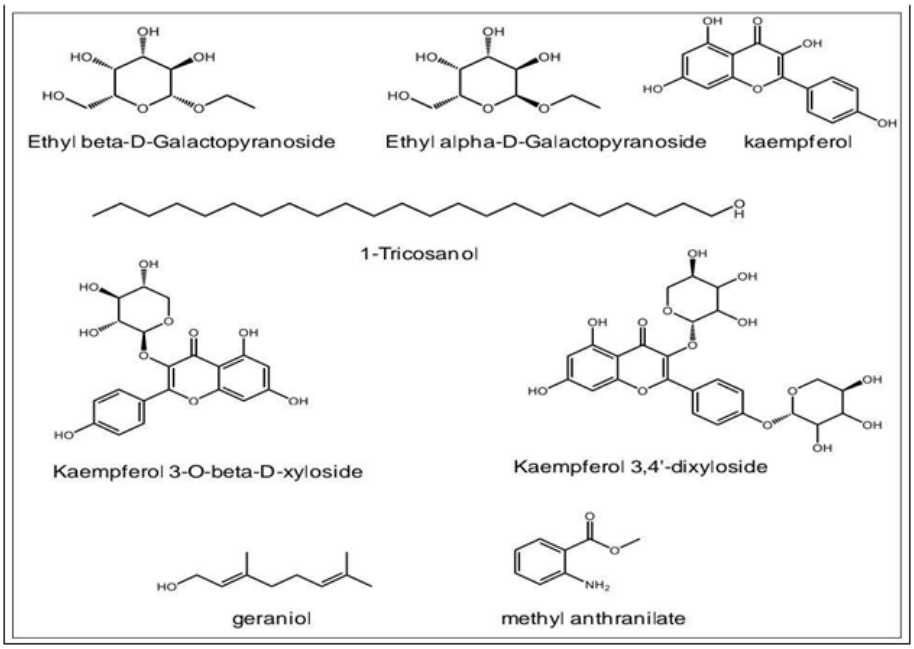

Figure 2. Chemical structure of phytoconstituents

Ethnomedicinal uses of the plant or plant parts

- The **plant or parts of the plant** also has medicinal uses in other countries apart from Bangladesh. The plant is used for gonorrhea, insomnia and low sex drive by people of Kollihills, Namakkal district, Tamil Nadu, India [38].
- **Flowers** are taken as tea in the Dominican Republic for women's health conditions
- **Root, stem, flower, whole plant** used in tumor, cosmetic, laxative, cooling, placebo, sexual disorder, hair color, emetic, diuretic, gonorrhea [39].

Reported Pharmacological Activities

- The **flower and bulb extracts of the plant** were shown to have anti-inflammatory and antispasmodic, diuretic and emetic properties. Bulbsare also used for curing rashes in infants [40].

- The **leaves part of the plant** was shown to contain flavonoid compounds such as, kaempferol, kaempferol-3-O-xyloside, kaempferol-3-40-O-xyloside, kaempferol 3-O glucoside and polianthoside B [36,41].
- Fresh **tubers part of the plant** contain steroid glycosides including two spirostanols (polianthosides B and C) and four furostanolic (polianthosidesD–G) along with a saponin [42].
- It is reported that **bud extracts of the plant** possess larvicidal and biting deterrence activity against Anopheles stephensi and Culex Quinquefasciatus[43].
- The tuberose **flower methanolic extract** had strong antibacterial activity against Proteus mirabilis and Esherichiacoli [44].Additionally, according to the description of ancient Ayurveda, tuberose floral aroma has an excellent effect on the brain and heart. By stimulating the right side of the brain, which is responsible for our creative thought, it can aid to increase emotional, psychological, and artistic impulses [45].Due to the presence of secondary metabolites such as polyphenols, nonpolar volatiles, and essential oils, aromatic plants are now well recognised as natural sources of antioxidants [46].These metabolites can donate hydrogen to free radicals, limiting the production of new radicals. Atoms or groups of atoms with at least one unpaired electron are known as free radicals, and they are extremely reactive. Their increased concentration in the human body may cause inflammations or neurological and psychiatric diseases [47].
- **Anti-tumor activity:** Geraniol (trans-3,7-dimethyl-2,6-octadien-1-ol) has been shown to possess anti-tumor properties. It has been demonstrated to have multiple effects on mevalonate and lipid metabolism in the human hepatocarcinoma cell line, Hep G2. The growth rate and 3-hydroxymethylglutaryl coenzyme A reductase (HMG-CoA reductase) activity of Hep G2 cells were also inhibited by geraniol concentrations up to100 micromol/L [48]. The compound has also shown promise against pancreatic cancer, which is generally refractory to chemotherapy. In a study conducted with MIA PaCa-2 human pancreatic cancer cells, three naturally derived isoprenoids –perillyl alcohol, farnesol, and geraniol demonstrated additive anti-proliferative effects. All three compounds induced a G(0)/G(1) cell cycle arrest that coincided with an increase in the expression of the cyclin kinase inhibitor proteins p21 (Cip 1) and p27 (Kip 1) and a reduction in cyclin A, cyclin B1, and cyclin-dependent kinase (Cdk) 2 protein levels [49].
- **Anti-inflammatory activity:** Geraniol also has pharmacological potential in lung inflammatory diseases where oxidative stress is a critical factor. The compound has been shown to protect t-BHP (tert butyl hydroxyl peroxide)-stressed rat alveolar macrophages [50].
- **Antibacterial activity:** Essential oil from Cymbopogon martinii containing geraniol as the active compound exhibited a broad inhibition spectrum against ten Escherichia coli serotypes: three enterotoxigenic, two enteropathogenic, three enteroinvasive and two shiga toxin producers [51]. The essential oil of Helichrysum italicum reportedly significantly reduced the multidrug resistance of Enterobacter aerogenes, Escherichia coli, Pseudomonas aeruginosa, and Acinetobacter baumannii. Geraniol, a component of the oil was found to significantly increase the efficacy of -lactams, quinolones, and chloramphenicol [52].
- **Anthelmintic activity:** The volatile oil from the leaves and flowers of the

same plant, containing geraniol, showed anthelmintic activity by causing paralysis and death of the Indian earthworm Pheretima posthuma [53]. The acaricidal activity of the compound (derived from oil of Pelargonium graveolens leaves) has also been demonstrated against the storage food mite, Tyrophagus putrescentiae [54]. The compound also showed efficacy against fish parasites of the Anisakidae family (Contracaecum sp.), which can cause the parasitic disease anisakiasis, when fish is eaten without proper cooking [55]. Field trials conducted in two farms near Rabat (Morocco) showed that 1% geraniol has a preventive effect against Hyalomma ticks, which affect cattle [56]. Geraniol also showed the longest protection time from mosquito bites when compared with other botanical natural repellents against three mosquito species –Psorophora ferox, Aedes atlanticus, and Aedes mitchellae [57].

- Besides geraniol, kaempferol is another phyto component of the plant with a large number of attributed beneficial effects and as a consequence, possible therapeutic importance. This review will not attempt to discuss the various pharmacological activities of kaempferol. Briefly, the compound appears to be beneficial in various forms of **cancer, Parkinson's disease, diabetes, cardiovascular diseases, arthritis, and erectile dysfunction and as an antioxidant and uterine relaxant**[58, 59, 60, 61, 62, 63, 64, 65].

Conclusion

The tuberose (Polianthestuberosa) is a perennial agave plant of the Agavaceae family, whose extracts are utilized in perfumery as a middle note. Polianthestuberosa L. is a flowering plant in the Agavaceaefamily (also known as Asparagaceae and Amaryllidaceae by some botanists) that is commonly found in Bangladeshi gardens. In India, tuberose is commonly known as Gulchari and Galshabbo in Hindi, Rajanigandha in Bengali, Sukandaraji and Nelasanpengi in Telugu, NilaSampangi in Tamil and Sugandharaja in Kannada. The plant is used for a variety of folk medicinal purposes, including tumour, cosmetic, laxative, cooling, placebo, sexual disturbance, hair colour, emetic, diuretic, and gonorrhea. The plant contains a number of flavonoids and other polyphenols, which can be of possible therapeutic use against a number of diseases resulting from or causing oxidative stress like diabetes, rheumatoid arthritis and cardiovascular disorders.

There is always a demand for new and novel varieties in the floriculture sector. The key novelty identifiers in the world wide flower industry are the flower's colour, form,, and perfume. In breeding, genetic variety is very significant. For crop improvement and more specifically development of new varieties, a number of plant breeding methods like cross-breeding, induced mutagenesis and molecular breeding are available. Plant breeders have produced a large variety of flowers by classical genetic techniques. In this review; information about the plant including its taxonomy, morphological characters, ethnobotanical uses, propagation & cultivation, reported phytochemical constituents and pharmacological activities were studied successfully.

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