REVIEW ARTICLE

Some Useful Plants in Treatment of Ganga Water Pollution and Human Healthcare in India

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Abstract

Long distance of 2510 km long river basin, originating from Bhagirathi from Gangotri glacier in Uttarakhand, The Ganga is the most sacred river of India which is symbolic of purity and moksha and plays a crucial role in the growth of Indian civilization and economy. The river Ganga which is often called "Holy Ganga" or "Mother Ganga" has been exposed to many anthropogenic pollutants for several decades, and due to that it has grasped a serious and evolving problem. Anthropogenic sources include industrial release, domestic wastes, and municipal sewage. Pollution due to religious activities such as religious bathing and idol immersion is also a major concern. According to earlier studies, the 12 municipal towns located along the Ganga river basin leading to Haridwar, discharge nearly 89 million liters of municipal sewage into the river. High amounts of inorganic and organic pollutants are coming from industrial effluents from different industries. These industrial organic and inorganic pollutants are very serious issues for human health as they are carcinogenic and mutagenic to humans which ultimately cause neurological and physiological and other disorders. Like yoga, India can offer numerous plant-based treatments to the world that can benefit the whole on a larger basis. Learning from old-age traditions of Ayurveda, various trees and herbs along the plains of river Ganga are customarily used by many local and rural people in meeting their day-to-day needs and health care. The study highlights some of the potential plant species like *Achyranthes aspera, Acorus calamus, Aegle marmelos, Ajuga bracteosa, Arisaema tortuosum, Aristolochia indica, Asparagus racemosus, Ficus religiosa, Gloriosa superba, Helminthostachys zeylanica, Hemidesmus indicus, Tephrosea purpurea, Terminalia chebula, Tinospora cordifolia, Terminalia bellirica and Withania sominifera etc.*, that can be combinedly used with modern medical science with the vast invaluable knowledge to provide the effective and affordable treatment for various diseases caused by polluted water of Ganga.

Keywords: Ganga River Basin, Water Pollution, Potential Plant species, Plant-based Treatment, Natural Ecosystem.

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Introduction

The river Ganga holds immense significance in Indian civilization's history, culture, and traditions. It is considered a Goddess and holds a sacred place in our hearts. Countless rituals and temples associated with Ganga signify her status as a deity. Great saints and deities like Lord Krishna, Lord Rama, Lord Shiva, Lord Vishnu, Sri Swami Sivananda, and Sri Ramakrishna have all praised her greatness in various verses. However, despite her revered status, Ganga is facing severe pollution due to the discharge of untreated municipal sewage, industrial effluents, and waste from other nonpoint sources. The Ganga basin, which houses about 40 percent of India's population, generates about 6414 MLD of waste water, and three-fourths of the river's pollution comes from untreated municipal sewage (CPCB, 2016). The main sources of pollution are urban liquid waste, industrial liquid waste, large-scale bathing of cattle, throwing of dead bodies in the river, and surface runoff from solid waste landfills and dumpsites (Dwivedi *et al*., 2018). Further more, several industries also discharge waste water in the riparian zone, which contributes to pollution. Although the joining of tributaries into the mainstream gives Ganga the power to degrade toxins and wash them away, the loss of water velocity is cited as a more serious factor contributing to the rise in pollution levels. Without adequate flow, toxins and bacteria cannot be flushed and degraded, posing a threat to humans (Franci *et al*., 2015).

We have the knowledge, skill, and wealth to make our rivers completely free from pollution, but we lack the will. Especially our political and bureaucratic apathy to the problem of environmental degradation in general and river pollution, in particular, is highly deplorable and appealing. Since the Ganga represents our traditional Indian culture and her present miserable, state represents the present pathetic state of our traditional Indian culture. None of our prophets would approve of the present development, which has caused the disappearance of tens of thousands of plant and animal species. As our country undergoes a transformation from an agricultural to an industrial economy, the impact of environmental pollution has become more pronounced. The magnitude and speed of these changes have far-reaching consequences. The river Ganga, revered as a symbol of purity and virtue by countless individuals and representative of all other rivers in India, is not an ordinary body of water. Despite being increasingly polluted, millions of devotees still flock to its banks to take a holy dip, perform Aachman (a mouthful of holy water), and absolve themselves of sins.

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The state of Uttar Pradesh is botanically rich on account of its diverse forests, rivers, valleys, and hillocks. A large number of trees, shrubs, and herbs are growing throughout Gangetic plains along the length of the Ganga River. According to (Wagh, 2017), the vast array of wild plants in the region serves as a crucial resource for humankind, providing food, medicine, fiber, oil, fuels, housing, clothing, contraceptives, and other essential materials. This region is home to numerous rural and indigenous communities who rely on the surrounding flora for their day-to-day needs and healthcare, collecting and utilizing various shrubs, herbs, roots, tubers, leaves, flowers, fruits, and seeds (Maheshwari *et al.*, 1981; Maheshwari *et al.*, 1986; Singh and Prakash, 1994; Singh and Prakash, 1996; Singh and Prakash 2003; Jain, 1981; Jain, 1991). Some of the potential plant species like *Achyranthes aspera, Acorus calamus, Aegle marmelos*, *Ajuga bracteosa, Arisaema tortuosum, Aristolochia indica, Asparagus racemosus, Azadirachta indica, Bacopa monnieri, Boerhavia diffusa, Bombax ceiba, Cassia fistula, Cassia tora, Celastrus paniculatus, Curculigo orchioides, Cyperus rotundus, Diospyros exsculpta, Emblica officinalis, Euphorbia fusiformis, Ficusreligiosa, Gloriosa superba, Helminthostachys zeylanica, Hemidesmus indicus, Tephrosea purpurea, Terminalia chebula, Tinospora cordifolia, Terminalia bellirica, Withania sominifera, Bauhinia vahlii, Buchanania lanzan, Canavallia gladiata, Oryza rufipogon, Shorea robusta, Sterculia villosa* etc. Rural and local populations use these for addressing their everyday healthcare needs and treating a range of illnesses and conditions.

Earlier Initiatives for Clean Ganga

Prime Minister of India established the Central Gange authority (CGA) in February 1985 to oversee the restoration of the Ganga to its original state and manage its cleaning. In the sequence, The Gange project Directorate (GPD) was established in June 1985, as a wing of the Department of Environment. Further, A multipurpose project, Ganga action plan (GAP) was launched on June 14, 1986, at Varanasi to abate pollution, improve water quality, and to conserve biodiversity. The focus of the effort was also on the development of an approach for integrated management of river basins, along with extensive research into similar practices. Although Gange action plan has not achieved full success despite the expenditure of approximately 2,000 crore rupees due to many reasons. In a study some potential plant species (Jain, 1981; Jain, 1991, ethnobotany) like *Spathodea campanulata*, *Nerium indium*, *Mangifera caesia*, *Ceiba speciosa*, *Ficus religiosa*, *Manilkara zapota*, *Ficus benghalensis*, *Azadirachta indica*, *Polyalthia longifolia*, *Psidium guajava*, *Washingtonia robusta*, *Nerium oleander*, *Acacia arabica*, *Madhuca longifolia*, *Ocimum sanctum*, *Tectona grandis*, *Cupressus sempervirens*, *Withania somnifera*, *Frangipani*, *Moringa oleifera*, *Albizia amara*, *Tamarindus indica*, *Mangifera indica*, *Theobroma cacao*, *Rhus lancia*, *Bambusa bambos* (Krishnaveni *et al.,* 2013; Yadav *et al.,* 2012) have been found useful for removing water pollution by absorbing nutrients, degrading organic matter present in wastewater and checking mobilization of toxic metals to other resources.

Present Initiatives for Clean Ganga

In 2009, the Indian government established the National Ganga River Basin authority (NGRBA) as an empowered entity under the Environment (Protection) Act. Its primary aim is to adopt a new approach to cleaning the river Ganga by implementing comprehensive management strategies that encompass the entire river basin. The NGRBA also addresses issues such as minimum ecological flows and pollution abatement measures. It ensures that developments such as hydropower projects are carried out sustainably while maintaining adequate ecological flows. This body does not serve as an additional clearance mechanism but rather develops a river basin management plan and implements specific interventions to treat sewage. The NGRBA focuses on ensuring sufficient ecological flow in the river and taking measures to curb pollution. More information about the NGRBA can be found at https://nmcg.nic.in/ngrbaread.aspx.

Development of Constructed Wetland and Phytoremediation: A Green Clean Technology for Ganga Pollution

In recent times, a matter of serious concern is that human and industrial activities is endlessly increasing along its banks which is vastly polluting this sacred river. Several government initiatives such as the Ganga action plan will create awareness among the people on this important issue as it can only be successfully implemented with the people's participation (Rai *et al.,* 2014). In this context, it is also desirable to establish vegetation on the bank of the river for pollution amelioration, soil stabilization, and water turbidity. Substantial vegetation is also required to improve its aesthetic values (Singh *et al.,* 2022). The plantation is set to have a significant impact on phytoremediation and the cleaning of the river. This is due to its ability to absorb nutrients, break down the organic matter present in wastewater, and prevent the movement of toxic metals to other areas (Rai *et al.,* 2013). Many plant species have been identified as pollution cleansers. Plants and microbes have the capacity to bio-accumulate and transform toxic substances into simple and non-toxic compounds. Recently, various plant species have been utilized to extract a significant amount of heavy metals from metalliferous wastewater (Rezania *et al.,* 2016). For instance, Mitchell and Karathanasis (1995) employed bulrush plants, examined the potential of *Phragmites australis* for heavy metal removal using surface and subsurface flow to simulate wetlands in NaCl- enriched wastewater, and investigated (Mungur *et al.,* 1997) the root systems of four plant species, viz., P. australis, Typha latifolia, *Schoenoplectus lacustris*, and *Iris pseudacorus*, for their ability to accumulate heavy metals. Our ongoing research programs on improving water quality through plantations have shown that many plants can be used for the phytoremediation of polluted rivers. Pollutants can also be removed from the Ganga river through the plantation of phytoremediator plant species and aquatic plants as well (Jeevanantham *et al.*, 2019). Since many catchment areas of the Ganga are completely denuded, which straightaway needs forestation. Plants will bring rain, retain water, and check soil erosion.

An artificial marsh or swamp, known as a constructed wetland, is utilized for various purposes such as treating anthropogenic discharge including wastewater, stormwater runoff, or sewage. It can also serve as a habitat for wildlife or as a means of land reclamation following mining or other disturbances. Unlike constructed wetlands, natural wetlands act as biofilters, removing sediments and pollutants such as heavy metals from the water (Singh *et al.,* 2021). To achieve similar outcomes, various plants such as cattails (Typha spp.), Water Hyacinth (*Eichhornia crassipes*), and Pontederia spp. are commonly used across the globe. Among them, *Eichhornia crassipes* (water hyacinth) has demonstrated fast growth and has become dominant, covering 80% of the wetland surface. Accompanying species such as *Typha domingensis* (Cattail) and Panicum elephantipes (elephant panicgrass) have attained 14% and 4% cover respectively. The constructed wetland was successful in removing 86% of Cr and 67% of Ni. Zn concentrations were also below 50 µg 1-1 in most samplings with 70 and 60% removal of phosphate and ammonium (Maine *et al.,* 2006).

The aspiration for an efficient sewage treatment system is to generate discharge of exceptional quality at an affordable cost, visually pleasing, and with no adverse effects on the environment. However, the truth is that the vast majority of traditional wastewater treatment systems built in the last 25 years discharge effluents that surpass permissible levels of pollutants, are energy-intensive, require extensive maintenance, and emit unpleasant odors in the surrounding area. Additionally, they create secondary complications related to the disposal of sludge. Gradually, it is becoming clear that conventional treatment plants are not the only alternative for wastewater treatment. In Indian cities, conventional sewage treatment plants are not functioning at their maximum capacity due to power and land shortages. As a result, these plants typically release effluents that have high levels of biochemical oxygen demand (BOD) and suspended solids (SS), often around 30 mg/L for each parameter (Heathcote, 2000). So, besides the plantation, constructed wetlands in the sewage and domestic wastes along major cities located on the bank will provide a habitat for wildlife *vis a vis* remediation of pollution.

There are two types of constructed wetland technologies (CWTSs): free water surface (FWS) and subsurface flow (SF). The FWS system involves a shallow bed or channel with aquatic vegetation, where the contaminated water is exposed to the atmosphere. In contrast, the SF system is a bed of permeable media that supports the root system of vegetation, and the water to be treated is not exposed to the atmosphere. The water level is maintained below the surface, and a complex matrix of distinct aerobic and anaerobic treatment zones is established to improve wastewater treatment. The recommended length-to-width ratio is 2-4:1 for SF systems and up to 10:1 for SSF systems (Shutes, 2000). It is recommended to have pre-treatment structures such as oil and grit interceptors, a settlement trench or pond, a rip-rap zone to reduce flow, and a post-treatment pond. In case of excessive flow, an overflow should be present to direct the water to the watercourse without passing through the wetland. According to (Shutes, 2000), a minimum detention time of 4 hours is desirable, and flow rates at the inlet zone should not exceed 0.3 to 0.5 m/s to ensure sufficient sedimentation. To improve metal removal performance through surface adsorption, Shutes recommended using a mixture of gravel and soil. Constructed wetlands require a substrate that supports emergent plants with a high hydraulic conductivity of 10^{-5} m/s or less, and gravel is the most suitable substrate for this purpose (Scholes, 2008). According to (Haghnazar *et al.,* 2023), *Phragmites australis* and *Typha latifolia* are often utilized for their capacity to tolerate, absorb, and filter metals.

Current Status

Constructed wetlands, also known as natural or alternative wastewater treatment technologies, have gained significant popularity worldwide. They are being used for treating various types of wastewater such as acid mine drainage, barn wastes, feedlot runoff in agriculture, urban storm water runoff, industrial wastewater, and for secondary and tertiary treatment of municipal sewage. Developed countries such as Canada and France have adopted constructed wetlands in addition to conventional treatment plants. These wetlands are not only preferred for their aesthetic appeal, but they also offer benefits such as improving indoor air quality when housed in a greenhouse enclosure. However, in order to promote the use of constructed wetlands, it is important to evaluate their pros and cons to ensure efficient management. Despite their popularity, regulatory agencies have been hesitant to support constructed wetlands due to concerns about their effectiveness and reliability compared to established technologies. Nevertheless, many engineers and scientists argue that conventional technologies have their own shortcomings and alternative technologies are necessary to address the challenges of wastewater treatment.

Role of Trees in River Conservation

Several attempts have been made occasionally to control river water pollution; however, its visible compacts are not seen so far. Central and state pollution control boards have been assigned to control the sewage and industrial effluent discharge in the river, but sewage/effluent treatment plants have not been established as desired and many of the established units are non-functional. This is a costly affair and therefore many disputes and litigations have emerged regarding the imposition of this condition on the already licensed industries. A low-cost technique may also be adopted which apart from alleviating the pollution load, controls significantly the river silting and aids to maintain the oxygen buffer in the atmosphere. According to Ansari (2023), river water and sediments are concentrated with heavy metals, namely cadmium, zinc, nickel, lead, chromium, and copper. Additionally, toxic levels of nitrate and phosphates have also been detected. Tree roots absorb such pollutants to some extent, but there has been little attention on the plantation of trees for pollution abatement as it does not provide direct commercial gains to the persons who undertake the job. In contrast forestry or horticulture, plantation appears to be more lucrative in view of better monetary returns against the investment. However, if we could account for the intangible benefits of the tree's ecosystem services, its value needs much more time than the value of horticulture or forest produce.

Benefits of Natural Ecosystems to Human Societies

Ecosystem services are essential to civilization and provide living space for about 14 million inhabitants (Schirpke, 2023). Natural aquatic ecosystem, from fish to frogs and microbes to macrophytes, provide massive services to mankind. Rising alarms focus on the quickening pace of biodiversity loss and diminishing ecological function within aquatic ecosystems that continue to threaten these limitless natural profits (Lynch, *et al.*, 2023). The costs are generally hidden from traditional economic accounting. Most ecosystem services operate on a vast and complex scale, with intricacies that are largely unexplored, making them difficult to replace with technology. Unfortunately, human activities are already causing significant damage to the flow of ecosystem services on a large scale, and if current trends persist, it is likely that humanity will irreversibly transform almost all of Earth's remaining natural ecosystems within a few decades. As a result of human activities, natural ecosystems are being modified or destroyed, leading to a decline in ecological services.

Characters of Ecosystem Services for Effective Water Pollution Control

Oxygen production, Production of ecosystem goods; nutrient cycle, Generation and maintenance of biodiversity, Climate control and vitality of life, Mitigation of floods and droughts, Pollination and seed dispersal, Natural pest control services, Aesthetic beauty and Cultural benefits (spiritual and recreational) No significant progress has been achieved yet despite several restrictions made on industries and the enforcement of antipollution laws to curb pollution. Modern technologies are deemed to be very costly and developing countries may not afford pollution treatment plants. Therefore, some control through phytoremediation would be feasible by developing green belts like shelter belts and avenue plantations of pollution-resistant/scavenging trees. Urban forestry has been restricted to avenue plantations so far, without considering the efficacy of plants against vehicular pollutants, and gardens are primarily developed with a greater emphasis on floriculture from a bio-aesthetic point of view. The importance of tree plantations has not been well understood to alleviate the problem of water pollution and river silting, where the typically assorted vegetation for the purpose would be much more useful in cleaning the atmosphere by absorbing certain toxic metals from water and air pollutants from its surroundings. Airflow within and immediately above vegetation couples plant and air pollutants (source receptors) and sinks with the atmospheric systems (Corada, 2023). Most of the catchment area of Ganga is completely denuded and needs forestation not only to check soil erosion and pollution control but also to maintain a balanced hydrological cycle. Rainfall depletion patterns in several areas have been attributed to the massive-scale deforestation of tropical forests in many countries (Singh and Kushwaha, 2008; Grainger *et al.,* 2013). Roots and litter of trees conserve the soil moisture and check runoff, evaporation, and transpiration from the tree leaves to aid in precipitation. If we could maintain the original flow of the river, and good embankment plantations, several contaminants merging in the river water can be diffused significantly in the self-purifying capacity of the river. Forest communities differ significantly from the higher altitudes of Gangotri (temperate zone) to the plains near Haridwar in sub-tropical and tropical zones. Apart from the species consisting of the dispersed fibrous root systems, local plant species would also be considered for supporting the rural population for their livelihood needs. An afforestation program with different plant species having hyper-accumulation potential and soil binding characteristics with bio-aesthetic and commercial value is proposed to be launched very soon. The help of local inhabitants, environmental activists, social organizations, and the forest department would be sought.

The success of a plantation at any given location depends on various factors not only meteorological but eco-physiological strategies of species like tolerance against water pollution and the total pollution scavenging potential. In brief, it is an eco-technological strategy (Bhattacharjee *et al.*, 2021). Various researchers have attempted to determine the parameters for assessing the tolerance of a species. Initially, these studies included only three or four parameters with arbitrary mathematical input. However, later on, more extensive studies were carried out with a large number of samples, species, and parameters for statistical correlations. These studies led to the development of a relevant scientific model to determine the range of tolerance. The studies also revealed that in intolerant species, only two or three out of ten parameters exhibit a significant relationship with gaseous pollutants. In contrast, in susceptible species, as many as nine or all parameters are affected, indicating the impairment of physiological and biochemical setup. It is evident that any assessment of plant tolerance should involve at least six or seven parameters. Furthermore, the choice of parameters is equally significant, with leaf area, dry weight ratio, superoxide dismutase, peroxidase, stomatal conductance, and amino acids being more reliable than traditionally investigated parameters like chlorophyll, sugars, and protein (Dubey and Dubey, 2000).

We propose a novel method for establishing a riverbank plantation, utilizing extensive field sampling of numerous species and quantifying the total scavenging potential (TSP) through both surface depositions and internal accumulation. This approach is entirely field-based and involves year-round sampling, representing a significant departure from traditional methods. The selection of potential species on the basis of previous work has been refined and updated including metabolic indicators (like LDR, transpiration rate, buffering index, NR activity), the foliage's evergreen nature, canopy architecture, etc. Several factors, such as tree species height, leaf area index, and water requirements, can govern the choice of species. For instance, Bauhinia variegata is a proficient scavenger but has weaker intolerance and is smaller in height. As a result, it can be utilized as a third-story species in the green belt (Sharma *et al.,* 2011). In contrast, Eucalyptus spp. is an excellent scavenger but tends to consume excessive water, has thin foliage, a poor crown, and releases antibacterial compounds through its leaf litter (Dubey and Dubey, 2000).

Spot surveys of the banks of the Ganga river have been done to determine various physio-chemical properties of soil, the pollution level in the water, and the vegetation cover around the river. Based on these results a detailed layout of the different plant species has been recommended to be planted along the bank may be prepared. Various pollution- tolerant species of dust scavengers, erosion barriers, pollutant absorbers, and economically important plants were suggested for the development of a green cover on the bank of the river. The choice of plants has been decided according to the plant height, foliage area, canopy architecture, rooting pattern tolerant to toxic metals, and hyper-accumulator species. The local inhabitants residing along the bank, the municipal workers engaged in

Table 1: Useful plant species around river Ganga for human-health care, food and Environmental problem

S. N.	*Local name*	*Botanical name*	*Family*	*Medicinal uses*	*References*
1.	Chaffflower/ Chirchita	Achyranthus aspera	Amaranthaceae	Teatment in ophthalmia/ Cutaneous disease	Trivedi (2004)
2.	Muskrat Root	Acorus calamus	Acoraceae	Digestive disorder/ Pain remover	Das *et al.* (2003)
3.	Bel	Aegle marmelos	Rutaceae	Stomach pain treatment	Manandhar *et al.* (1978); Korkina and Afanasev, (1996); Gond *et al.* (2007); Jain (1977)
4.	Bugleweed	Ajuba bracteosa	Lamiaceae	Treatment of rheumatism, Gout, Palsy, Amenorrhea	Khanavi *et al.* (2014)
5.	Whipcord Cobra Lily/Sarpa Makai	Arisaema totuosum	Araceae	Treatment in phlegm, Brochitis, Cold, Cough, Laryngitis	Mesfin *et al.* (2013)
6.	Hooka Bel	Aristolochia indica	Aristolochiaceae	Used in children diarrhoea, intermittent fever	Padhy (2021)
7.	Satavar	Asparagus racemosus	Asparagaceae	Root used in health supplement, milk enhancer in women	Kamat *et al.* (2000)
8.	Peepal	Ficus religiosa	Moraceae	Enhance fertility	Al-Snafi (2017); Ahuja *et al.* (2011)
9.	Glory Lily	Gloriosa superba	Liliaceae	Arthrirtis, Gout, rheumatism, Ulcer, Leprosy	Jain (2010); Kunle *et al.* (2012) Yadav I (2012); Malpani *et al.* (2010)
10.	Kamraj	Helminthostachys zeylanica	Ophioglossaceae	Rhizome used in dysentery, Malaria, Catarrh	Verma *et al.* (2007)
11.	Ananthmool	Hemidusmus indicus	Apocynaceae	Blood Purifier, Syphilis	Alam *et al.* (1998)
12.	Sarphunka	Tephrosea pupurea	Fabaceae	Tonic and Laxative Properties	Williamson *et al.* (1996)
13.	Harra	Termanalia chebula	Combretaceae	Antiseptic, Diuretic, Cardiotonic	Rangsriwong *et al.* (2009)
14.	Guduchi	Tinospora cordifolia	Menispermaceae	Urinary Diseases, Dyspepsia	Raghunathan *et al.* (1969); Sinha *et al.* (2004)
15.	Baheda	Termanalia bellerica	Combretaceae	Health and Digestive Supplement	Elizabeth, (2005); Deb *et al.* (2016)
16.	Ashwgandha	Withania somnifera	Solanaceae	Brain Stimulator, HairTreatment	Abhyankar and Chinchanikar (1996); Abou Zid *et al.* (2010); Abraham *et al.* (1968); Agarwal *et al.*, (1999); Al- Hindawi *et al.* (1992); Chaudhary (2010)
17.	Brahmi	Bacopa monnieri	Plantaginaceae	Hair Treatment, Memory Increaser	Tiwari, (2008); Azad *et al.* (2012)
18.	Punarnava	Boerhayia diffusa	Nyctaginaceae	Pain releif	Dora *et al.* (2018)
19.	Semal	Bombax ceiba	Malvaceae	Remove abdominal pain from dysentery	Wahab *et al.* (2012),
20.	Golden Shower	Cassia fistula	Fabaceae	Healing of wounds, Gastrointestinal illness.	Panda *et al.* (2011) Singh *et al.* (2013)
21.	Senna	Cassia tora	Caesalpinoideae	Skin disease	Acharya and Chatterjee (1975)
22.	Mal- Kangni	Celastrus paniculatus	Celastraceae	Ayurvedic medicine	Ahmad *et al.* (1994)
23.	Kali Musli	Curculigo orchioides	Amaryllidaceae	Immunostimulant, Antioxidant, Anticancer	Li *et al.* (2003)
24.	Java Grass	Cyperus rotundus	Cyperaceae	Antiparasitic	Ali *et al.* (2008)
25.	Tendu	Diospyros exsulpta	Ebanaceae	Abdominal Pain, Dysentery, menstrual troubles for making Beedi also for Smoking	Yang *et al.* (2014)
26.	Anwla	Emblica officinalis	Euphorbiaceae	Treatment of blood sugar, hypoglycemia (low blood sugar), hair fall, diarrhea, jaundice and inflammation.	Sharif *et al.* (2023)
27.	StemlessSpurge	Euphorbiafusiformis	Euphorbiaceae	Liver Disorder, Urinary stones, Skin disease	Abera (2014)
28.	Benth	Bauhinia vahlii	Caesalpiniaceae	Roasted seed of woody climber are edible	Bach *et al.* (2014)

29.	Chiraunji	Buchnania lanzan	Anacardiaceae	Use as dry fruit	Mehta *et al.* (2011)
30.	Sword Bean	Canavaliia gladiata	Fabaceae	Unripe pod are used as vegetable	Rajaram and Janardhanan (1992)
31.	Sal Tree	Shorea robusta	Dipterocarpaceae	Timber	Giannasi and Niklas (1977)
32.	Elephant Rope Tree	Sterculia villosa	Malvaceae	Paper making	Mandal *et al.* (2010)
33.	African TulipTree	Spathodea campanulata	Bignoniaceae	Campanulate flower	Begum *et al.* (2020)
34.	Nerium Oleander	Nerium indicum	Apocynaceae	Use in treatment of skin cancer, Malaria, Heart tonic, Tumors.	Redha (2020)
35.	Silk Floss Tree	Ceiba speciosa	Malvaceae	Make canoes, Wood paper, Wood pulp, Rope.	"Ceiba speciosa." Wikipedia, (2017)
36.	White Mango	Mangifera caesia	Anacardiaceae	Use as creamy juice	Dawd *et al.* (2012)
37.	Chicle/Sapodilla	Manikara zapota	Sapotaceae	Fruits use as nutritional supplement	von Reis Altschul, (2013)
38.	Bargad	Ficus bengalensis	Moraceae	Skin ailments	Jain and Rao (1977).
39.	False Ashoka	Polyalthia longifolia	Annonaceae	Use as in skin infection and viral infection	Saket and singh (2017)
40.	Guava	Psidium guajava	Myrtaceae	Ripe fruit	Akinjogunla *et al.* (2011)
41.	Mexican Fan Palm	Washingtoniarobusta	Arecaceae	Produce edible fruits	Basu *et al.* (2014)
42.	Oleander	Nerium oleander	Apocynaceae	Ornamental plant	Bandara *et al.* (2010)
43.	Babul	Acacia arabica	Fabaceae	Bark use in toothpaste	Fagg *et al.* (2005), Soloman *et al.* (2010)
44.	Mahuwa	Madhuca longifolia	Sapotaceae	Fruit use in making alcohol	Oudhia *et al.* (2008)
45.	Tulsi	Ocimum sanctum	Lamiaceae	Holy plant and use in Cough cold remove mouth infection	Lanzotti (2014); Parekh and Chanda (2007); Hakkim *et al.* (2008)
46.	Teak	Tectona grandis	Lamiaceae	Timber	Varma *et al.* (2007)
47.	Drumstick	Moringa oleifera	Moringaceae	Flower, pods and leaves use as vegetable	Oliveira *et al.* (1999)
48.	Krishna Siris	Albizia amara	Fabaceae	Treatment in piles, diarrhea, gonorrhea	Shirisha *et al.* (2013)
49.	Imli	Tamarindus indicus	Fabaceae	Edible sour pods, Use as fodder, Also use in pharmaindustries	Nagarjun *et al.* (1998); Rao *et al.* (1997) ; Warda *et al.* (2007); Kulkarni *et al.* (1993) Altyb (2020)
50.	Mango	Mangifera indica	Anacardiaceae	Pulpy ripe or unripe edible fruit	Martinez *et al.* (2000)
51.	Thorny Bamboo	Bambusa bambos	Poaceae	Anti-Inflammatory, Astringent, Laxative, Diuretic, Anti-Ulcer, Anti-Obesity	Damyanto *et al.* (2020)
52.	Water Hyacinth	Eichornia crassipes	Pontederiaceae	Use in biogas- Biofuel production, medicinal functions, Compostp production, Bioremediation.	Gaurav *et al.* (2020)
53.	Tall Grass	Phragmitus australis	Poaceae	Use as phytodepuration Or In natural water treatment	Ye *et al.* (1997)
54.	Orchid Tree	Bauhinia variegata	Fabaceae	Antioxidants, Anticancer activity	Akerele (1990.), Sharma *et al.* (2011)
55.	Bamboo Tree	Bambussa Spp	Poaceae	Use in making houses, Huts, Boats, Fences, Furniture and handicrafts	Damyanto *et al.* (2020)
56.	Seesham	Dalbergia sisso	Papilionaceae	Stem pulp used in dysentery dtreatment	Kumar *et al.* (2006)
57.	Cassod Tree	Cassia siamea	Caesalpiniodeae	Fuel wood	Singh *et al.* (2013)
58.	Red Date	Ziziphus jujuba	Rhamnaceae	Use in Asthma, Gastro- Intestinal problem and liver disease	Mahran *et al.* (1976)
59.	Ber	Ziziphus mauritiana	Rhamnaceae	Decoction of leaf used in treatment in malaria	Reyes-Garcia *et al.* (2006)

60.	Rubber Tree	Ficus elastica	Moraceae	Pain, Rheumatism,Hypertension, Anemia, Wound, Hernia, Hemorrhoids	Awuchi (2019)
60.	White Fig	Ficus infectoria	Moraceae	Liver ailments	Arora and Kaur (1999)
61.	Manila Tamarind/ Monkeypod Tree	Pithecolobium dulce	Fabaceae	Treating gastrointestinaldisorder	Parrotta (1991)
62.	Kala Siris	Albizzia lebek	Mimosceae	Used in tannin wood timber	Anis *et al.* (2000)
63.	Bougainvillea Flower	Bougainvillea spectabilis	Nyctaginaceae	Floweing plant	Islam *et al.* (2016)
64.	Jamun	Syzygium cumini	Myrtaceae	Making vinegar ripe fruit used in Stomachache/Indigestion	Ayyanar *et al.* (2013)
65.	Arjun	Termanalia arjuna	Combretaceae	Extract of bark in Jaundice treatment	Mandal *et al.* (2010); Das et al. (2010); Nema *et al.* (2012)
66.	Mahanim	Ailanthus excelsa	Simaroubaceae	Timber and food	Jain and Jain (2016)
67.	Bans	Dendrocalamus strictus	Poaceae	Stem juice in earache	Cordell and Colvard (2012)
68.	Rohini	Mallotus philippensis	Euphorbiaceae	Stem used in Jaundice treatment	Manandher (1998)
69.	Gandhela	Murraya koenigii	Rutaceae	Boil treatment	Ganai and Nawachoo (2003)
70.	Harshingar	Nyctanthus arbor- tristis	Oleaceae	Seed Paste in pile treatment	Ody (1993)
71.	Benth	Pithecellobiumdulce	Casalpinaceae	Shoot and leaves used in Fodder	Tabuti *et al.* (2012)
72.	Chir	Pinus roxburghii	Pinaceae	Stem used in headache	Jain(1981); Jain (1991)
73.	Burans	Rhododendron orborium	Ericaceae	Flowers used in beverages	Devi *et al.* (2018)
74.	Dhawari	Woodfordiafruticosa	Lythraceae	Root paste of treatment inpiles	Foster and Johnson (2006)
75.	Khasru	Quercus semecarpifolia	Fagaceae	Timber	Dhar *et al.* (1997)
76.	Jamula	Salix tetrasperma	Salicaceae	Timber	Chhetree *et al.* (2010)
77.	Kadamb	Anthocephalus chinensis	Rubiaceae	Fruits ripe unripe use	Rafshanjani *et al.* (2014)
78.	Sababul	Leucaena latisiliqua	Papillionaceae	Fodder	Tiwari *et al.* (2019)
79.	Ganna	Saccharum officinarum	Poeceae	Fresh juice	Jain (1963)
80.	Neem	Azadirachta indica	Meliaceae	Leaves used for wound treatment and remove fungal infection	Zizka *et al.* (2015)

different sewage treatment plants, and people from non-governmental organizations and social workers were involved at the time of the execution of the plantation. The potential plant species that had been planted tentatively along the bank of the river include various pollution-tolerant species (Waller *et al.*, 1993; Masondo *et al.*, 2019) like *Pterospermum acerifolium, Bauhinia variegata, Bambusa* spp, *Dalbergia sissoo, Cassia siamea, Ziziphus jujuba, Z. mauritiana, A. cadamba, C. lanceolatus, Ficus bengalensis, F. religiosa, F. elastica, F. infectoria, Azadirachta indica, Polyalthia longifolia, Pithecolobium, dulce, Albizzia lebbek, Bougainvillea spectabilis, Syzygium cumini, Phyllanthus emblica, Leucaena leucocephala, Terminalia arjuna*, etc (Solomon-Wisdom and Shittu, 2010). Plants around river Ganga having their medicinal potential against various discuses and their nutritional and other values have be mentioned in Table 1.

Conclusion

Given the current state of water pollution in the Ganga, it is increasingly important to adopt a new approach to planting vegetation along its banks. Introducing decorative plants with pollution-reducing capabilities within the aquatic system and surrounding areas will not only beautify the ecosystem but also help combat pollution and create a cleaner and greener environment for the future. Proper plantation strategies will bring healthy aquatic life and will ultimately combat water pollution. The importance of trees alongside the Ganga is now widely documented as they too purify the water and help it to make it pollutant-free. India's ironic biodiversity of native and exotic trees offers a wide range of choices to be used for plantation along the river making it pollutant-free river. Based on the available literature various tree species including exotic trees be explored for controlling river pollution and also their possible use in health care. However, elementary knowledge of their biological relationship with the aquatic environment is absolutely necessary to mitigate the Ganga river pollution for which the local people, governmental bodies, and environmental scientists, botanists all will have to work together against this serious issue.

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Author Contribution

MK Shukla: Data mining, data analysis, data compilation, conceptualization, visualization, writing original draft review. AP: Data correction, writing-review and editing.
AS and NT: Manuscript correction and plagiarism check BK Gupta: data compilation writing-review, editing.

Conflict of Interest

The author declares that there is no conflict of interest.

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