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## EXPLORING THE MEDICINAL PROPERTIES, THERAPEUTIC USES, AND ECO-FRIENDLY WATER FILTRATION POTENTIAL OF TULSI (*HOLY BASIL*): A COMPREHENSIVE REVIEW

Jyoti Singh<sup>\*1</sup>, Dilip Suthar<sup>1</sup>, Dinesh Kumar Upadhyay<sup>1</sup>, Rita Yadav<sup>1</sup> and Priyanka Jaiswal<sup>2</sup>

School of Pharmaceutical Sciences<sup>1</sup>, Seedling School of Nursing<sup>2</sup>, Jaipur National University, Jaipur - 302017, Rajasthan, India.

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### Correspondence to Author:

**Ms. Jyoti Singh**

Assistant Professor,  
School of Pharmaceutical Sciences,  
Jaipur National University, Jaipur -  
302017, Rajasthan, India.

**E-mail:** jyoti.renu00@gmail.com

**ABSTRACT:** In this comprehensive review, the medicinal properties of Tulsi are thoroughly explored, highlighting its esteemed therapeutic uses that are widely regarded as safe, cost-effective and efficacious owing to its abundant availability. Tulsi a member of the genus *Ocimum* and a revered medicinal plant native to India has garnered significant recognition and reverence for its profound healing capabilities across generations. Its roots, leaves, and seeds boast a diverse array of medicinal properties, offering a broad spectrum of benefits to human health. Renowned for its anti-aging, immunomodulatory, antimicrobial, and anticancer properties, Tulsi has earned the esteemed title of the ‘Queen of Herbs’ in India symbolizing its paramount importance in traditional Ayurvedic and Unani medicinal practices. Characterized by its distinct square stem and aromatic essence, Tulsi holds a prominent place in Ayurvedic medicine with its extracts frequently utilized in remedies for ailments ranging from common colds and headaches to gastrointestinal disorders, cardiovascular ailments, poisoning, and even malaria.

**INTRODUCTION:** Tulsi also known as Holy Basil, holds a revered status in the Lamiaceae family, with its botanical name being *Ocimum sanctum*<sup>1,2</sup>. Revered as the ‘queen of herbs’ Tulsi boasts a plethora of medicinal properties intrinsic to herbal remedies. It exists in two primary types: Green Tulsi (Ram Tulsi) and Black Tulsi (Krishna Tulsi), both sharing similar characteristics. In Hindu tradition, Tulsi is emblematic with the alternate name Vishnupriya signifying its association with pleasing Lord Vishnu.

In Ayurveda, the holistic healing system of ancient India, Tulsi has been a cornerstone for millennia due to its multifaceted health benefits<sup>3</sup>. All parts of the plant including leaves and seeds are utilitarian contributing to its reputation as a general vitalizer enhancing physical endurance. Rich in constituents like eugenol, Tulsi exhibits COX-2 inhibitory properties as corroborated by various research studies.

Tulsi's presence in Indian households is not merely customary but deeply symbolic, believed to safeguard families from malevolent influences<sup>4</sup>. Its leaves are consumed in various forms, from herbal tea to dried powder and even incorporated with honey or ghee. In Hinduism, Tulsi is venerated with the belief that gods reside in different parts of the plant, underscoring its sacred significance. The medicinal prowess of Holy Basil extends to

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respiratory ailments aiding in the expulsion of phlegm and alleviating bronchial congestion. It is a trusted remedy for stomach disorders and plays a crucial role in combating diseases like bronchitis, influenza and asthma. During the monsoon season, when malaria and dengue pose threats, Tulsi emerges as a natural shield. Moreover, Tulsi contributes to cardiovascular health by regulating cholesterol levels and promoting a healthy heart<sup>5,6</sup>. Widely distributed across India and various countries in Asia and beyond, Holy Basil's presence spans diverse geographical regions attesting to its universal acclaim and significance. In essence, Tulsi stands as a beacon of holistic wellness, intertwining medicinal, cultural, and spiritual dimensions to enrich lives across civilizations and generations<sup>7</sup>.

**Varieties of Tulsi:** Dark Tulsi or Krishna Tulsi, Green Tulsi or Rama tulsi.

**MORPHOLOGY:** Tulsi scientifically known as *Ocimum sanctum* **Table 1** is a distinctive shrub characterized by its erect, branched structure, typically reaching a mature height of 30-60cm. The plant's morphology includes simple aromatic leaves that are branched, opposite, obtuse, and elliptical with dentate margins, measuring up to 5cm in length. Its flowers form elongated racemes arranged in close whorls exhibiting a vibrant purple hue<sup>8,9</sup>. The seeds of Tulsi are radish-yellow while its fruits are small in size. Cultivation of Tulsi typically commences after the rainy season with seeds sown and nurtured until Maturity which occurs after a few months. This cultivation cycle ensures optimal growth and development of the plant allowing it to thrive and fulfill its medicinal and cultural significance<sup>10</sup>.

**TABLE 1: TAXONOMY**

Kingdom	Plantae
Divisio	Magnoliophyta
Class	Magnoliopsida
Order	Lamiales
Family	Labiatae
Genus	<i>Ocimum</i>
Species	<i>Sanctum</i>

**Vernacular Names:** Hindu, Kalatulasi, Tulasi, Kannada, Vishnu Tulasi, Kari Tulasi, Sri Tulasi, Tulashigida, English – Holy Basil, Malayalam Tulasi, Trttavu Karuttarttavu, Niella Tirtua, Shiva Tulasi, Telugu, Tulasi, Gaggera Chettu, Tamil

Tulaci, Karuttulaci, Bengali – Tulasi, Krishna Tulshi, Gujarati – Tulasi, Talasi, Punjab – Ban Tulsi, Tulsi, Marathi– Tulasa, Tulasi, Konkani– Tulsi

#### **Phytochemicals:**

**Fixed Oil:** Linoleic acid, Linolenic acid, Oleic acid, Palmitric acid, Stearic acid.

**Essential Oil:** Aromadendrene oxide, Benzaldehyde, Borneol, Bornyl acetate, Camphor, Caryophyllene oxide, cis- $\alpha$ Terpineol, Cubenol, Cardinene, D-Limonene, Eicosane, Eucalyptol, Eugenol, Farnesene, Farnesol, Furaldehyde, Germacrene, Heptanol, Humulene, Limonene, n-butylbenzoate, Ocimene, Oleic acid, Sabinene, Selinene, Phytol, Veridifloro,  $\alpha$ -Camphene,  $\alpha$ Myrcene,  $\alpha$ -Pinene,  $\beta$ -Pinene,  $\alpha$ -Thujene,  $\beta$ -Guaiene,  $\beta$ Gurjunene, methyl chavicol and linalool.

**Mineral Contents:** Vitamin C, Vitamin A, Calcium, Phosphours, Chromium, Copper, Zink, Iron.

**Alcoholic Extract:** Aesculectin, Aesculin, Apgenin, Caffeic acid, Chlogenic Acid, Circineol, Gallic Acid, Galuteolin, Isorientin, Isovitexin, Luteolin, Molludistin, Orientin, Procatechuic acid, Stigmsterol, Urosolic acid, Vallinin, Viceni, Vitexin, Vllinin acid.

**Tulsi's Applications in Ayurvedic Medicine:** Tulsi (*Ocimum sanctum*) has great therapeutic potential in Ayurvedic medicine and provides numerous advantages for overall health. Tulsi is widely acknowledged for its high concentration of essential oils and Antioxidants which help to reduce stress on the body. As a result, it is a powerful plant for treating mental stress. Beyond Hindus and Indian's customary use more and more individuals throughout the world are realizing the therapeutic benefits of tulsi<sup>11</sup>. Tulsi extracts are used in Ayurvedic medicine to treat a variety of illnesses such as the common cold, headaches, stomach problems, inflammation, infections, heart disease, poisoning, cataracts, and malaria. Because of tulsi's actions on the neurological system, the heart is supported, digestion is aided by the secretion of digestive enzymes and flatulence is avoided because of its cleansing<sup>12</sup>. Qualities, Tulsi has been shown to be effective in lowering cholesterol levels and purifies the blood by getting

rid of pollutants. In addition to being effective against a variety of infectious ailments due to its antibacterial and anti-parasitic qualities, recent research indicates that it may also be able to prevent radiation poisoning and fight malignant cells<sup>13</sup>. Tulsi is a vital herb in Ayurvedic medicine and has great medical value in addition to its religious significance. Many medical applications exist for the essential oil derived from Karpoora Tulsi, especially for treating skin diseases including ringworm, dermatitis, and bug bites. Tulsi also helps the body get rid of toxins and poisons, improve digestive and lung conditions, and lower fevers. Tulsi is advantageous for those with diabetes because it helps control blood sugar levels, and its antimicrobial qualities help prevent<sup>14</sup>.

**Tulsi in Contemporary Health:** Tulsi (*Ocimum sanctum*) may provide useful therapy choices for a range of medical ailments, from ulcers and high cholesterol to Type-2 diabetes<sup>15</sup>, obesity, and weakened immune systems linked to diseases like cancer and AIDS, according to new study in modern medicine. The intrinsic qualities of many Tulsi variants such as essential oils that contain the anti-inflammatory compound eugenol and different acids with antioxidant and anti-inflammatory activities, support the traditional applications of Tulsi in Ayurveda. Studies show that because of its complex pharmacological profile, tulsi has a great deal of promise as a therapeutic agent. Its effectiveness in reducing inflammatory disorders is supported by the presence of eugenol and other bioactive components and its antioxidant qualities help to Fight oxidative stress and promote general well-being. Tulsi's ability to treat ailments like ulcers, elevated cholesterol, and Type-2 diabetes further highlights its promise as a natural substitute for traditional therapies<sup>16</sup>.

It is especially helpful in enhancing immunological responses in those with weakened immune systems, such as those with cancer and AIDS because of its capacity to regulate immune activity. Tulsi is a viable candidate for additional investigation in contemporary medicine due to the synergistic effects of its bioactive ingredients with potential uses in supplementary therapy and preventative healthcare<sup>17</sup>. Tulsi's entire potential will become clear with more research into the mechanisms of action behind its therapeutic effects which will

open the door to the creation of cutting-edge treatment modalities that make use of this age-old medicinal herb<sup>18</sup>.

**Applications of Natural Medicine:** The medicinal systems of traditional India such as Siddha, Unani, and Ayurveda have long acknowledged the benefits of Tulsi (*Ocimum sanctum*) in the treatment of a variety of ailments. These traditional medical systems which have their roots in antiquity, use natural treatments made from plants and herbs, Tulsi being one of the main ingredients<sup>19</sup>. Tulsi is used in Siddha, Unani, and Ayurvedic medicine to treat a variety of skin disorders, fevers, coughs, and internal illnesses.

To cure bronchitis, Ayurvedic doctors often make a liquid tonic from Tulsi leaves. For added effectiveness, the tonic might be mixed with cardamom or lemon juice. These ancient medical System's holistic perspective highlights the significance of preserving harmony and balance within the body considering health as a condition where the mental, spiritual and bodily aspects are all in balance. These traditional medical methods are in line with the many pharmacological characteristics of tulsi such as its anti-inflammatory, antibacterial, and immunomodulatory activities. Siddha, Unani, and Ayurvedic practitioners hope to improve general health and treat a variety of diseases by including Tulsi into their treatment regimens<sup>20</sup>. Tulsi's importance as a useful therapeutic herb in the context of traditional Indian medicine is highlighted by its rich cultural legacy and long-standing tradition of use. The integration of Tulsi into mainstream healthcare practices may open up new avenues for the management of common health conditions as contemporary research on the herb's therapeutic potential continues. At the same time, it will preserve and honor the ancient wisdom that has been passed down through generations in India's traditional medicine systems<sup>21</sup>.

**Tulsi in Your House:** Discovering the Tulsi plant's full potential offers more benefits than only health; it may also enhance your food and provide lovely aesthetic appeal to your environment. Tulsi is a multipurpose plant that enhances the flavor of many foods and makes a calming tea. It is well-known for its delicious flavor and simplicity of

growing<sup>22</sup>. Tulsi brings a burst of aromatic richness to your cooking, enhancing the flavors of salads, soups, sauces and drinks. Its unusual flavor enhances a variety of recipes with depth and complexity, whether it is used fresh or dried, adding its particular character to your culinary creations. In addition to its culinary use, tulsi plants are attractive as ornamentals, adding a hint of organic beauty to both outdoor and interior environments. Along with its rich foliage and lovely scent, this shrub adds a magical touch to your house or yard, making it more visually appealing. In addition, Tulsi cultivation is quite easy and produces a lot of benefits with little upkeep. Because it is non-toxic, pets can safely play with it and everyone who lives there will live in harmony<sup>23</sup>. The Tulsi plant thrives in little care and is a great addition to any home, whether it is planted outdoors or in a pot indoors. Tulsi plant: it can be used as a decorative element or added to your regular cooking practice. Its many uses will improve both the culinary and aesthetic parts of your life. Accept the adaptability of tulsi and use its delicious flavors and organic charm to transform your living areas<sup>24</sup>.

**Chemical Composition and its uses:** Tulsi's chemical makeup is complex but it mostly consists of eugenol or 1-hydroxy-2-methoxy-4-allylbenzene. Numerous phytochemical substances are included in this chemical formula. These chemicals which are found throughout the entire plant have antibacterial, anti-inflammatory, antioxidant, adaptogenic, and immune-boosting qualities. Any kind of Tulsi consumption provides the body with these advantageous qualities, strengthening its resistance to illnesses and other health problems.

**Protective agent:** polyphenol Acidro-smarinic Antioxidant: Tulsi's polyphenol acidro-smarinic acid functions as a potent antioxidant, shielding the body's cells from harm brought on by free radicals. Cell damage can result from the body's excessive oxidation which rosmarinic acid aids to prevent from occurring<sup>25</sup>.

**Antibacterial:** Tulsi contains antibacterial compounds such as terpenes and carvacrol. Moreover, sesquiterpene B-caryophyllene provides a comparable objective. This ingredient which is

found naturally in tulsi is a food additive recognized by the FDA that protects the body against pathogenic microorganisms. Anti-inflammatory Apart from its antioxidant qualities, rosmarinic acid has good anti-inflammatory actions as well. Pengin, another substance present in the composition of tulsi performs the similar purpose<sup>26</sup>. Eugenol is the primary anti-inflammatory ingredient in tulsi. It is in charge of regulating the pancreatic beta cell function which increases insulin release and controls blood sugar levels in the body<sup>27</sup>.

**Adaptogenic:** Tulsi is perfect sources of properties that assist regulate mood swings and promote mental clarity and calm. The two most important adaptogenic substances found in Tulsi's chemical formula are eugenol and caryophyllene. The primary cause of stress, corticosterone can be effectively lowered by these substances. They also improve memory and reduce the likelihood of age-related mental health issues. Both ursolic and oleanolic acids operate as adaptogens and are excellent at lowering stress levels<sup>28</sup>.

**Immuno-Modulator:** The body needs immuno-modulators to stabilize, heal and keep the immune system operating in a balanced and appropriate manner. Tulsi has outstanding immune-boosting qualities that fortify the body against external threats while preserving general equilibrium<sup>20</sup>.

**The Vital Antimalarial:** It has been observed that Tulsi oil is 100% effective in killing Culex mosquitoes. Tulsi has demonstrated outstanding antimalarial activity in trials. The repellent effect of its extracts lasts for approximately two hours and has noticeable insecticidal activity against mosquitoes<sup>22</sup>.

**Anti-diabetic:** Forty human subjects with Type II diabetes participated in a randomized, placebo-controlled crossover single-blind study. Subjects in the four-week trial were given a daily dose of 2.5 g of powdered Tulsi leaves or a placebo for two weeks at a time. In comparison to blood glucose levels during placebo treatment, the results demonstrated a drop of 17.6% in fasting blood glucose and a decline of 7.3% in postprandial blood glucose with Tulsi treatment<sup>29</sup>.

**Antifertility:** It has been observed that ursolic acid, a significant component of the leaves has antifertility effects in rats and mice. Its antiestrogenic action has been linked to this effect, which may be the cause of the inhibition of ovum implantation in females and the arrest of spermatogenesis in males. This component might show promise as a side-effect-free antifertility medication<sup>23,30</sup>.

**Regarding Heart Conditions:** Tulsi (basil) functions as a depressant and raises blood pressure. Regular use can aid in the prevention of heart attacks. One gram of dry Tulsi leaves, a teaspoon of butter, some candy sugar or honey can all be combined to make a tonic<sup>31</sup>. Take this tonic twice a day, right before bed in the morning and at night. Taking Tulsi leaf tea aids in sustaining normal blood pressure.

**Other Effects:** The leaves are applied to the fingernails and toenails during fever when the limbs are cold and they are used as a paste in parasitic skin illnesses. Children with bronchitis and catarrh are given the leaf juice. According to reports, the plant possesses stimulant, diaphoretic, and carminative qualities. The plant's infusion is used as a mouthwash to soothe toothaches and coughs. It helps with cholera, cramps, convulsions, migraines, and fevers. Making tea from the leaves of Tulsi leaves helps avoid coughs, colds, and other illnesses linked to the 'Kapha' dosha in the body. In addition, this tea doubles as an energy drink<sup>32</sup>.

**Medicinal uses of Tulsi:** Native to South Asia, Tulsi (*Ocimum sanctum*) is also referred to as holy basil. Its therapeutic benefits have been known for ages and Ayurveda, the Indian system of herbal medicine, still bases its treatment on it. Although Tulsi has long been one of the most widely utilized medicinal plants in India, the West is beginning to recognize the potential benefits of Tulsi as well<sup>33</sup>. Its bactericidal qualities have been recognized by cosmetic industries which use it in a variety of beauty products.

**Skin:** In a piece for Salam Research, a stand-alone business in Rochester, New Hampshire, Steven Maimes talks about the advantages and applications of holy basil. According to Maimes, a November 2004 publication, Tulsi 'reduces eczema and

psoriasis and helps skin diseases like leprosy and staph infection." Because of its antimicrobial. Tulsi helps in skin regeneration and eliminates harmful pollutants due to its antibacterial qualities<sup>34</sup>.

**Anti-Aging:** Ursolic acid, a substance found in Tulsi helps keep wrinkles at bay and preserves the suppleness of young skin. Because of this, Tulsi is now a common component in herbal cosmetics like face masks and lotions. Apply a mixture of Tulsi powder and water to your face for youthful, fresh skin. After drying give everything a good water rinse<sup>31,35</sup>.

**Beauty and Restorative:** Tulsi is often a part of everyday beauty routines for Indian women. Tulsi powder can be used to help get rid of blemishes on the face and steaming the face with boiled Tulsi leaves and lemon juice can naturally freshen the skin. Tulsi is well renowned for purifying and cleaning the blood and Leucoderma and acne can both be effectively treated with a prepared Tulsi paste. Added Benefits of Tulsi also referred to as an 'elixir of life' has a rich and diverse traditional use. The mind and body are calmed by consuming Tulsi tea or decoction infused with stress-resilient Tulsi. Tulsi juice is a common Ayurvedic remedy that works well for treating respiratory conditions like bronchitis, persistent coughing and fever. Additionally Tulsi helps decrease cholesterol<sup>36</sup>.

Gargling warm water down the throat might help relieve sore throats and preserve the heart and blood vessels. Ringworm can also be treated using a paste made of Tulsi and black pepper.

**Antibiotic Protection:** Tulsi provides significant natural antibacterial, antiviral, and antifungal protection making it helpful in treating both systemic and localized infections<sup>37</sup>.

**Heart and Vascular Protection:** It protects the heart and blood arteries by lowering harmful cholesterol and stress-related high blood pressure. It also has minor blood-thinning properties that lessen the chance of strokes<sup>38</sup>.

**Liver Support:** Tulsi is known to promote the metabolic breakdown and removal of harmful substances from the blood, support healthy liver function and combat a number of liver illnesses<sup>39</sup>.

**Lung and Bronchial Support:** Tulsi is known to help cure a number of significant allergic, inflammatory and viral illnesses that affect the lungs and associated tissues, in addition to its overall beneficial effects on respiratory health.

**Nutritional Content:** Vitamins C and A, minerals like calcium, zinc, and iron, and other important nutrients are all abundant in Tulsi also known as holy basil.

Moreover, it has chlorophyll and several more phytonutrients. Tulsi also improves how well nutrients from food and other herbs are absorbed, digested, and used<sup>40</sup>.

**Complement of Allopathic Medicine:** Tulsi enhances the efficacy of allopathic therapy and lessens the possibility of adverse effects. Among its many advantages are that it lowers fevers, guards against stomach ulcers, controls blood sugar in diabetics and fosters periodontal and dental health. In addition, tulsi prevents mercury poisoning, speeds up bone fracture recovery, eases cramps and nausea and works as a natural insect repellent for lice and mosquitoes<sup>25</sup>.

**Effects of Pharmacology:** Several therapeutic benefits of Tulsi have been attributed in ancient Ayurvedic medicine. Its medicinal potential including its anabolic, hypoglycemic, smooth muscle relaxant, cardiac depressant, adaptogenic, and immunomodulatory qualities has been further supported by recent pharmacological research<sup>29</sup>.

**Amazing Medicinal Qualities:** Tulsi is well known for its ability to effectively treat jaundice. Jaundice can be efficiently treated with a combination of 10 Tulsi leaves and 10 grams of radish juice taken three times a day with jaggery for a month<sup>41</sup>.

**Eye Issues:** Tulsi is frequently used to treat issues related to the eyes. Applying a viscous solution derived from ground Tulsi leaves to the eyes helps reduce inflammation and night blindness.

**Mouth Ulcers:** Tulsi works well for curing lesions, mouth ulcers and associated problems. Chewing Tulsi leaves or using a paste made from Tulsi extract might help alleviate oral health issues such as gum and tooth sensitivity<sup>22</sup>.

**Pile:** Tulsi is also useful in the treatment of piles. Thirty minutes of soaking five Tulsi leaves in drinking water and then eating the Frequent use of water can help reduce piles.

**Cold and Fever:** Tulsi is a suggested treatment for fever that is linked to the common cold. Fever and cold symptoms can be relieved by boiling seven holy basil leaves and five cloves in water until it decreases to half, then adding rock salt and drinking the beverage hot. Children's cold symptoms and respiratory congestion can be relieved by combining Tulsi juice with honey<sup>42,43</sup>.

**Stomach-aches:** Regular consumption of a Tulsi and ginger juice mixture might help relieve stomach-aches and cramps<sup>44</sup>.

**Worms in Stomach:** For two days, drink hot Tulsi and ginger juice every three hours to help get rid of worms in the stomach<sup>45</sup>.

**Acidity:** Tulsi can assist in addressing seminal issues. To boost sperm and increase male fertility, ingest 50 g sugar candy mixed with Tulsi seeds (or roots) every day with milk<sup>46</sup>.

**Prevention and Recovery from Swine Flu:** Tulsi's antiviral qualities can help ward against the swine flu and speed up the healing process. Swine flu can be avoided and recovered from by consuming the juice or paste of 20–25 medium-sized Tulsi leaves twice a day on an empty stomach. Traditionally, water-soaked Tulsi leaves are offered to people with the flu and cold to strengthen immunity and speed healing in Hindu temples<sup>43,47</sup>.

**Macking of Eco-friendly Water Filter:**

**Antibacterial Activity:** In tap and river water, the antibacterial qualities of Tulsi (*Ocimum sanctum*) leaf extract were examined. After testing the extract at different concentrations (from 100 to 600 mg l-1), the highest concentration demonstrated the strongest antibacterial action in 15 to 16 hours. By using the spread plate method and minimum bacterial concentration (MBC), the extract showed strong antibacterial action, especially at 500 mg l-1 and 600 mg l-1 concentrations<sup>18,48</sup>.

**Natural Coagulant:** Chemical oxygen demand (COD), turbidity and pH of sewage water have all

been reduced by using holy basil also known as Tulsi as a natural coagulant. Tulsi showed remarkable effectiveness in lowering turbidity (69.82%) and COD (43.11%) at a dosage of 150 mg/100 ml making it an economical and effective choice for treatment of wastewater<sup>49</sup>.

Efficiency in Removing Heavy Metals: Research has shown that Tulsi may effectively eliminate heavy metals from water, including lead (Pb), cadmium (Cd), chromium (Cr), iron (Fe), copper (Cu), and zinc (Zn). Due to its adsorption properties, it is a cost-effective and environmentally benign way to reduce metal contamination in water sources<sup>46, 50</sup>.

**CONCLUSION:** Tulsi is an essential ingredient for boosting health and wellbeing because of its exceptional therapeutic qualities. Numerous studies have confirmed its safety and effectiveness in a range of applications. Tulsi known as the "Queen of Herbs" of India is a common ingredient in Ayurvedic medicine and cosmetics. Its consumption in a variety of forms is advantageous and safe, providing relief from conditions including the flu, colds, and sore throats. Tulsi also has an essential function in the purification of water acting as a coagulant, heavy metal remover and natural antibacterial. It is a favored option for water treatment solutions because to its ease of use, affordability and environmental friendliness, guaranteeing sterile and therapeutic water with no negative side effects.

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