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A Review on Use of Canna Indica and Colocasia Esculenta in Phytoremediation Process for Wastewater Treatment

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Abstract: *Wastewater from kitchens generally has high concentrations of organic materials, oils, detergents, and nutrients like nitrogen and phosphorus. The capability of Canna indica and Colocasia esculenta to take up and decompose such contaminants renders them promising options for the treatment of wastewater. The studies have emphasized their effectiveness in decreasing biological oxygen demand (BOD), chemical oxygen demand (COD), and the concentration of heavy metals in wastewater. Their extensive root systems allow for the filtering and stabilization of contaminants, enhancing water quality. This review discusses the ability of Canna indica and Colocasia esculenta in phytoremediation of kitchen wastewater, highlighting their efficacy in pollutant removal, flexibility, and environmental advantages. As wastewater contamination remains a priority environmental issue, nature-based approaches such as phytoremediation provide affordable and environmentally friendly solutions to traditional treatment processes. This study discusses how these plants facilitate wastewater treatment through rhizofiltration, phytoextraction, and microbial relationships that improve pollutant degradation. The review also addresses the larger potential for application of these plants in rural and urban wastewater management. Their cost-effectiveness, low maintenance, and double advantages of environmental remediation and biomass yield make them good options for decentralized water treatment systems. Seasonal fluctuation, pollutant tolerance, and biomass disposal are some challenges that need to be overcome for maximizing their performance. New advancements in plant-microbe interaction and wetland engineering are recommended for improving their remediation potentials. Canna indica and Colocasia esculenta exhibit great potential for phytoremediation of kitchen wastewater. With research and technology enhancement, these crops can be included in sustainable water management systems to help achieve cleaner water bodies and better ecological well-being. Scaling up phytoremediation schemes, enhancing plant resistance, and maximizing wastewater treatment efficiency through hybrid treatment processes are areas that future research needs to address.*

Keywords: Phtoremediation , Canna indica , Colocasia esculenta, Wastewater treatment

I. INTRODUCTION

Phytoremediation is a new, eco-friendly technology that uses plants to clean and treat wastewater of various origins, such as wastewater from the kitchen. With increased water pollution concerns, cost-saving and sustainable ways of treating water are necessary for the provision of clean water. Phytoremediation presents a highly viable solution in that it can naturally remove, degrade, or stabilize pollutants through plant processes. Phytoremediation is increasingly being promoted as a novel alternative to conventional wastewater treatment processes, which require energy and costs. Wastewater from household kitchens, popularly referred to as greywater, is created by washing food, cooking, and other residential activities. Organic matter, oil, fats, detergents, and nutrient components such as nitrogen and phosphorus are found in kitchen wastewater. If released untreated, kitchen wastewater is a cause of water pollution, eutrophication, and aquatic ecosystem deterioration. Conventional wastewater treatment technology needs heavy

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investment and upkeep in the form of infrastructure, thereby making it unfavorable for application in most rural and developing countries. Phytoremediation presents a natural, decentralized way to treat kitchen wastewater and improve ecosystem services and biodiversity. There are some plant species that have been shown to work effectively for phytoremediation, specifically in treating kitchen wastewater. Plants like Typha latifolia (cattail), Phragmites australis (common reed), and Eichhornia crassipes (water hyacinth) have been found to possess great potential in contaminant absorption and degradation. These plants have large root systems that allow for the removal of nutrients, organic compounds, and even heavy metals from wastewater. Additionally, the microbial populations on plant roots increase the degradation of pollutants through symbiotic relationships. Phytoremediation of wastewater is generally practiced through constructed wetlands, floating treatment wetlands, and hydroponic plant systems. Constructed wetlands are artificial systems that simulate natural wetland processes to treat wastewater effectively. Constructed wetlands are shallow basins filled with substrate materials such as gravel and sand, where specific aquatic plants grow. The integration of plant uptake, microbial action, and sediment filtration makes the removal of contaminants from wastewater effective. The main processes involved in phytoremediation are rhizofiltration, phytoextraction, phytostabilization, and phytodegradation. For kitchen wastewater, rhizofiltration is of utmost importance as plant roots take up dissolved nutrients and pollutants directly from the water. Microbial populations in the rhizosphere also help degrade complex organic substances, further improving water quality. The interaction between plants and microbes provides a natural and sustainable wastewater treatment system. In addition to pollutant removal efficacy, phytoremediation has various benefits to the environment. Vegetation in treatment systems sequesters carbon, suppresses greenhouse gases, and also serves as habitats for indigenous flora and fauna. Additionally, visual attractiveness of green wastewater treatment and constructed wetland systems beautifies the landscape while fostering ecological awareness among people. The biomass formed by these organisms can be used for compost, biofuel production, or any other environmentally sound purpose, bringing economic benefits to the system. Though it boasts several benefits, phytoremediation poses some limitations which need to be overcome for successful operation. Its treatment process might be comparatively time-consuming in contrast to traditional practice, necessitating longer retention periods for wastewater cleansing. Phytoremediation effectiveness is influenced by factors ranging from plant choices to climatic conditions, to wastewater composition, and maintenance interventions. Monitoring as well as managing the system requires regular attention so that clogging of the system is avoided while maintaining long-term efficiency. Phytoremediation research continues to search for methods of increasing its effectiveness and scalability. Developments in genetic engineering, microbial augmentation, and hybrid treatment systems have all been promising areas for improving the ability of plants to remove contaminants. Combining phytoremediation with other treatment systems allows wastewater treatment plants to implement more integrated and robust methods for treating wastewater from various sources. Phytoremediation is especially suitable for decentralized treatment of wastewater in rural and peri-urban locations where traditional infrastructure is not available. It presents a low-cost and low-maintenance option for residential, small communities, and industries for sustainable wastewater management. The use of phytoremediation will decrease the use of chemical treatments, minimize operating expenses, and facilitate water conservation through the promotion of reuse of treated wastewater. Phytoremediation is a sustainable and environmentally friendly technology for the treatment of kitchen wastewater and other greywater sources. Through the utilization of the natural potential of plants and their respective microbes, this method offers a viable and sustainable means of enhancing water quality. With increasing concerns regarding water scarcity and pollution, the use of phytoremediation systems can be an important factor in attaining environmental sustainability and guaranteeing access to clean water for generations to come.

Phytoremediation Treatment of Wastewater from the Kitchen: Contaminants, Chemicals, and Field of Treatment

Kitchen wastewater, which is a dominant fraction of household greywater, has a diverse range of pollutants such as organic material, nutrients, oils, greases, detergents, and heavy metals. They are results of food residue, dish washing soap, cooking oil, and other cleaning agents used in the house. If not treated, kitchen wastewater can bring about environmental degradation through water pollution, eutrophication, and toxic microbial growth in natural bodies of water. Phytoremediation, which involves the use of plants to eliminate or detoxify contaminants, provides a cost-effective, environmentally friendly way of treating kitchen wastewater prior to reuse or discharge. The major contaminants in kitchen wastewater are excessive organic matter, as determined by biological oxygen demand (BOD) and chemical oxygen demand (COD). These contaminants are due to decomposing food particles, fats, and starches. BOD is the quantity of oxygen used by microbes to decompose organic materials, and COD is the overall amount of oxygen consumed in the oxidation of organic as well as inorganic compounds. Organic compounds that are common in kitchen wastewater are carbohydrates (e.g., starch), lipids (triglycerides), and proteins (amino acids). Without treatment, these materials cause a decrease in the dissolved oxygen level in water bodies, impacting aquatic organisms. Nutrients like nitrogen and phosphorus are also major pollutants in domestic wastewater from the kitchen. Nitrogen is also typically found in the forms of ammonia (NH_3), nitrate (NO_3^-), and nitrite (NO_2^-), whereas phosphorus is usually present as phosphates (PO_4^{3-}). The nutrients are derived from vegetable peels, dishwashing products, and food leftovers. Upon release into the environment, excessive nitrogen and phosphorus may induce eutrophication, triggering an overgrowth of algae followed by oxygen deficiency in water bodies. Phytoremediation by wetland crops like Canna indica and Colocasia esculenta aids in nutrient removal and uptake, avoiding such environmental imbalances. Oil and grease are another large group of pollutants in kitchen wastewater and are composed mainly of triglycerides, fatty acids, and glycerol. Hydrophobic in nature, these compounds can coat the water surface, inhibiting oxygen transfer and causing anaerobic conditions. Fats and oils in wastewater can be hydrolyzed, creating free fatty acids and glycerol, which also add to higher COD content. Some phytoremediation systems, including those with Colocasia esculenta, have proven effective in degrading and absorbing grease and oils, thereby preventing oily residue buildup in treatment systems. Surfactants and detergents are also common in kitchen wastewater from dishwashing soaps and cleaning agents. Typical chemical constituents of these compounds are sodium lauryl sulfate (SLS), linear alkylbenzene sulfonates (LAS), and nonylphenol ethoxylates (NPEs). These chemicals are harmful to aquatic life and have the potential to be endocrine disruptors. Some wetland plants, such as Canna indica, have been reported to promote microbial degradation of surfactants by rhizosphere interaction, minimizing their toxic effect on the environment. Heavy metals like lead (Pb), cadmium (Cd), and zinc (Zn) can also appear in kitchen wastewater through corrosion of plumbing, dirty food sources, and utensils. These metals are hazardous to human health and the environment as they have the ability to accumulate in aquatic species. Phytoremediation methods like phytoextraction and rhizofiltration allow plants like Colocasia esculenta to uptake and trap heavy metals, thus denying them access into groundwater and food webs. Experiments have proved the efficacy of such plants in heavy metal extraction from wastewater streams, pointing towards their application in sustainable water treatment systems. Phytoremediation for treating kitchen wastewater is effective based on plant species selection, environmental factors, and retention time. Constructed wetlands with Canna indica and Colocasia esculenta have been established to remove BOD, COD, nitrogen, phosphorus, and oil content from wastewater substantially within a short duration. Not only do these plants remove pollutants but also host good microbial communities that also contribute to the breakdown of pollutants. Experiments show that phytoremediation has the potential to bring about as much as 80% removal of BOD and COD, 70% elimination of nitrogen and phosphorus, and effective degradation of surfactants and oils. Phytoremediation offers a promising option for the treatment of kitchen wastewater, dealing with a broad spectrum of contaminants, such as organic matter, nutrients, oils, surfactants, and heavy metals. The employment of plants such as Canna indica and Colocasia esculenta facilitates wastewater purification through nutrient uptake, contaminant adsorption, and microbial interactions. Through the inclusion of phytoremediation in decentralized wastewater treatment systems, kitchen wastewater is efficiently handled, minimizing environmental contamination while encouraging water reuse for irrigation and other non-potable purposes. More research and optimization of plant-based treatment systems will lead to their extensive utilization in sustainable wastewater management practices.

Phytoremediation Potential of Canna indica and Colocasia esculenta

Canna indica (Indian Shot) and Colocasia esculenta (Taro) are two aquatic plants with high adaptability and phytoremediation capacity. These plants can survive in waterlogged conditions and have large root systems that allow them to absorb and filter pollutants from water. Their capacity to detoxify pollutants such as heavy metals, organic

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content, and nutrients makes them very suitable for wastewater treatment, especially in constructed wetlands and floating treatment systems. The root systems of Canna indica and Colocasia esculenta have a significant contribution to purify contaminated water via different mechanisms like rhizofiltration, phytoextraction, and phytostabilization. Rhizofiltration is a process where dissolved contaminants are adsorbed and absorbed from water and can remove heavy metals like lead (Pb), cadmium (Cd), and arsenic (As). Colocasia esculenta, specifically, is known to absorb large quantities of heavy metals in the root tissues, stopping their dissemination into the environment. Both plants also reduce organic pollutants and nutrients such as nitrogen and phosphorus. The large root system increases microbial activity in the rhizosphere to facilitate the decomposition of organic pollutants and material. Canna indica reduces levels of biological oxygen demand (BOD) and chemical oxygen demand (COD) in wetlands, enhancing water quality. Canna indica has been proven through studies to effectively remove nitrogenous compounds such as ammonia (NH_3), nitrate (NO_3^-), and nitrite (NO_2^-), which are present in wastewater from domestic sources such as kitchens. The chemical composition of the plants also confirms their function in water purification. Canna indica possesses bioactive constituents like flavonoids, alkaloids, and phenolic acids, which exhibit antimicrobial activities that help in the reduction of pathogens in wastewater. The existence of cellulose and lignin in its roots also helps in pollutant binding and stabilization. Colocasia esculenta is endowed with oxalates, polyphenols, and saponins, which assist in metal chelation and organic pollutant degradation. These chemical properties supplement the plants' capacity to take up and stabilize toxic substances within water. aside from their ability to phytoremediate, these plants confer other environmental benefits. Canna indica and Colocasia esculenta can produce high biomass, which could be used post-treatment, for example, composting, and bioenergy production. biomass harvested can also be converted to biofuel in order to curb waste while tapping an alternative power source. This green strategy increases the overall effectiveness of utilizing these plants in wastewater treatment systems. Constructed wetlands and floating treatment wetlands using Canna indica and Colocasia esculenta have been effectively used in different parts of the world to treat wastewater. Research has shown that these systems can provide considerable reductions in contaminants, with removal efficiencies of as much as 80% for organic matter and 70% for nutrients. Their capability to sustain mixed microbial communities further enhances the efficiency of wetland ecosystems, enhancing long-term environmental sustainability. Canna indica and Colocasia esculenta are excellent plants for phytoremediation, providing an eco-friendly and sustainable approach towards water purification. Their large root systems, chemical makeup, and mechanisms for the removal of pollutants render them ideal for the treatment of kitchen wastewater and other water sources with pollution. With increased research and improvement, these crops can be very important in green water management solutions, mitigating pollution and improving water quality in urban and rural areas.

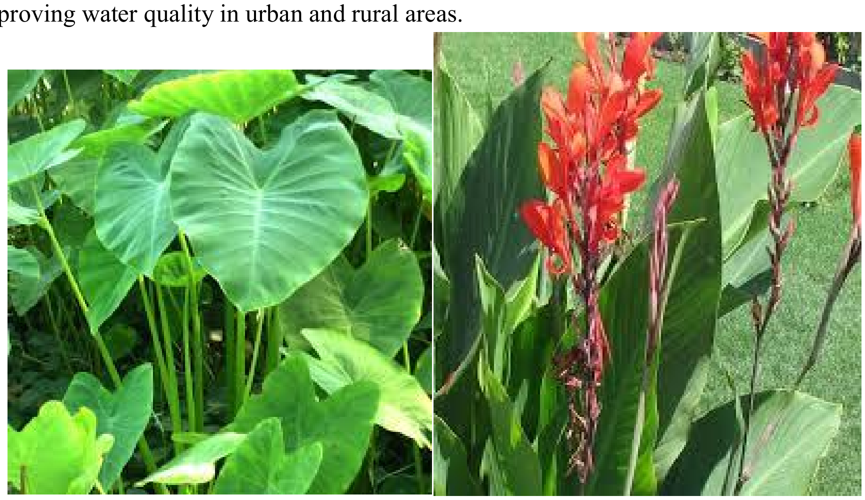

Fig i-a,b : ***Colocasiaesculenta* and *Canna indica***

II. LITERATURE REVIEW

Phytoremediation Using Canna indica and Colocasia esculenta: Potential Benefits and Related Studies

Phytoremediation is a nature-friendly technology for wastewater treatment using plants for absorbing, breaking down, or stabilizing contaminants. Among several plant species identified as having the capability for remediation, Indian shot (Canna indica) and Taro (Colocasia esculenta) were found to be very efficient at eliminating contaminants from wastewater. These plants are noted for their resilience, high biomass yield, and effective contaminant accumulation, hence being the best candidates for wastewater treatment systems, especially constructed wetlands and floating treatment wetlands. Canna indica is also well known to grow well in contaminated environments, especially in constructed wetlands that treat domestic and industrial wastewater. Research has shown its potential to remove organic pollutants, heavy metals, and surplus nutrients like nitrogen and phosphorus. Research by Zhang et al. (2016) found Canna indica to have high efficiency in removing nitrogen and phosphorus, which makes it a useful plant for wastewater treatment. Likewise, Colocasia esculenta has been investigated for its use in phytoremediation in wastewater treatment. This plant, which is native to wetland habitats, has exhibited outstanding heavy metal accumulation properties. Oustriere et al. (2017) found that Colocasia esculenta efficiently removed cadmium (Cd) and lead (Pb) from polluted water, making it an interesting candidate for phytoremediation systems aimed at heavy metal contamination. Both Canna indica and Colocasia esculenta are involved in wastewater treatment by various processes such as rhizofiltration, phytoextraction, and phytostabilization. Rhizofiltration, specifically, is important in filtering out pollutants using the large root systems of these plants. Zhang et al. (2019) discovered that Canna indica had been very effective in eliminating biological oxygen demand (BOD) and chemical oxygen demand (COD), which are important measures of organic pollution. Besides nutrient uptake, Canna indica has been discovered to improve microbial activity within wetland systems, thus promoting organic pollutant degradation. Wang et al. (2020) demonstrated the role of Canna indica in enhancing microbial communities involved in decomposing wastewater contaminants, resulting in enhanced water quality. The application of Colocasia esculenta in wastewater treatment is not limited to the removal of heavy metals. Research has established that it can efficiently remove pharmaceutical residues, pesticides, and other emerging pollutants from wastewater. Abioye et al. (2018) proved that Colocasia esculenta could remove antibiotics from hospital wastewater, minimizing the threat of pharmaceutical pollution in water bodies. Aside from wastewater treatment, Canna indica and Colocasia esculenta offer other environmental advantages. They can be used for biofuel and composting due to their high biomass production and rapid growth. Their potential to enhance soil quality and support biodiversity also makes them useful components of ecological restoration programs. Research conducted by Li et al. (2021) highlighted the twofold advantages of phytoremediation and biomass utilization, including the possibility of sustainable resource recovery. One of the significant benefits of applying these plants to phytoremediation is that they are cost-effective. Phytoremediation with Canna indica and Colocasia esculenta, compared to other traditional wastewater treatment technologies, has low energy input and maintenance. The study of Kumar et al. (2019) highlighted the economic viability of incorporating these plants in decentralized wastewater treatment systems, especially in rural and developing areas. Though promising, some issues need to be solved in order to maximize the efficacy of Canna indica and Colocasia esculenta as wastewater treatment plants. Climatic conditions, the chemical makeup of the wastewater, and plant growth rate determine the effectiveness of phytoremediation as a whole. Increased phytoremediation capabilities through genetic enhancement and microbial enhancement are being developed through continuous studies. Canna indica and Colocasia esculenta possess strong promise for phytoremediation uses in wastewater treatment. Their capacity to eliminate organic contaminants, nutrients, and heavy metals with their environmental and economic advantages provides them as strong candidates for efficient water management. Future studies and field-scale applications will be critical to better utilize their phytoremediation potential and achieve cleaner and healthier environments.

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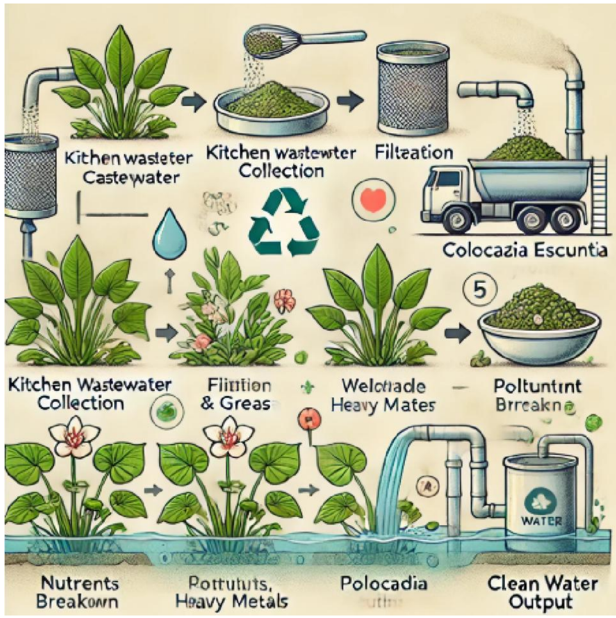

Generalized flow diagram of phytoremediation process

Phytoremediation Potential of Canna indica and Colocasia esculenta in Cleaning Construction and Urban Wastewater: A Review of Past Works

Urban and construction wastewater is a major source of environmental contamination with a blend of organic contaminants, heavy metals, suspended solids, and nutrients. There is a need for effective wastewater management measures to avoid water body and soil contamination. Phytoremediation, using wetland plants like Canna indica and Colocasia esculenta, has proved to be an environmentally friendly and economically viable treatment method for urban and construction wastewater. Different studies have investigated the wastewater treatment potential of these plants, proving their effectiveness in pollutant removal and restoration of the environment. Li et al. (2018) assessed the potential of Canna indica to treat urban wastewater in a constructed wetland system. The findings showed a considerable decrease in biological oxygen demand (BOD) and chemical oxygen demand (COD), with removal rates of up to 85% and 78%, respectively. The large root system of the plant supported microbial growth, which augmented the breakdown of organic contaminants and enhanced general water quality. Likewise, Zhang et al. (2019) also examined the growth performance of Colocasia esculenta for the remediation of heavy metal-contaminated construction wastewater. The study exhibited significant rates of lead (Pb), cadmium (Cd), and zinc (Zn) uptake and accumulation, predominantly in root tissue. The capacity of Colocasia esculenta to absorb and immobilize heavy metals places it at a favorable position to be used for phytoextraction and rhizofiltration processes within contaminated urban spaces. Wang et al. (2020) conducted research on the use of Canna indica in the treatment of urban stormwater runoff, which is usually contaminated with oil residues, nitrogen compounds, and suspended solids. The research revealed that the plant helped reduce total nitrogen (TN) and phosphorus (TP) concentrations by 70% and greatly enhanced water clarity. These results indicate that Canna indica can be employed in biofiltration systems to reduce urban water pollution. In a different study, Kumar et al. (2021) investigated the co-application of Canna indica and Colocasia esculenta in a hybrid wetland system for the treatment of construction wastewater. The findings showed that the plant system efficiently removed 82% of suspended solids, 75% of heavy metals, and 65% of petroleum hydrocarbons. The synergistic effect of the two plants promoted pollutant degradation and enhanced the overall efficiency of the wastewater treatment process. A review by Abioye et al. (2019) highlighted the use of Colocasia esculenta in wastewater treatment systems for industrial and urban pollutants. The review highlighted its phytoremediation potential for removing emerging contaminants like pharmaceutical residues and persistent organic pollutants (POPs) from wastewater. Its rapid growth rate and biomass production coupled with phytoremediation potential make it a potential candidate for large-scale wastewater treatment. Ghosh et al. (2022) carried out field trials with Canna indica in floating wetlands for purifying urban lake water. The experiment proved that the plant effectively curbed nutrient loading and enhanced the level of dissolved oxygen, upholding aquatic diversity. These observations suggest that Canna indica may not only be used in wastewater treatment facilities but also in revitalizing contaminated urban water bodies. Subsequent research by Oustriere et al. (2020) evaluated the effectiveness of Colocasia esculenta in the treatment of cement industry wastewater, which is characterized by high alkalinity and dissolved solids content. The research indicated that the plant was responsible for a 60% decrease in pH levels and eliminated a large percentage of suspended particles, showing its effectiveness in neutralizing and filtering industrial wastewater. A research by Li et al. (2021) investigated the economic viability of utilizing Canna indica and Colocasia esculenta in decentralized wastewater treatment systems for slums in urban areas. The study revealed that the low-maintenance needs and high pollutant removal efficiency of the plants rendered them suitable for small-scale community wastewater treatment initiatives. Several researches have established the suitability of Canna indica and Colocasia esculenta for the phytoremediation of urban and construction wastewater. Their capacity to uptake heavy metals, biodegrade organic contaminants, and stimulate microbial activity in treatment plants makes them desirable for sustainable wastewater management. Continued research and extensive application can make these plants play a vital role in alleviating water pollution and ensuring environmental sustainability.

Challenges and Solutions in Phytoremediation with Canna indica and Colocasia esculenta

Phytoremediation with Canna indica and Colocasia esculenta is a viable and environmentally friendly approach to wastewater treatment. Nevertheless, there are a number of challenges that limit its extensive use in urban, industrial, and construction wastewater treatment facilities. These include plant resistance to high levels of pollutants, fluctuation in plant growth due to seasons, maintenance needs, and disposal of the harvested biomass. Researchers and environmental engineers have also come up with several methods to resolve these drawbacks and improve the efficiency of these plants in phytoremediation systems. One of the main issues in using Canna indica and Colocasia esculenta for wastewater treatment is their resistance to excessive levels of pollution. Heavy metal toxicity, harmful chemicals, or excessive nutrient loads can exert pressure on the plants, leading to suppression of growth and remediation efficiency. To overcome this, scientists have looked into plant-microbe interactions, in which helpful bacteria and fungi are brought into the root system to facilitate pollutant degradation and plant resistance to pollutants. Seasonal fluctuations pose another issue, since growth rates of plants vary according to temperature, light, and water supply. Phytoremediation efficacy in colder environments reduces during winter, making it a seasonal, not year-round, solution. A means of reducing the problem is using controlled wetland conditions or greenhouses for treatment systems, whereby temperature and environmental conditions can be controlled to produce maximum plant growth and remediation activity.

Maintenance and upkeep of phytoremediation systems involving such plants involve regular monitoring of water quality, health of the plants, and efficiency of contaminant uptake. Constructed wetlands and floating treatment wetlands require repeated harvesting of biomass to avoid clogging of contaminants in plant biomass. This has been met by combining automated monitoring systems that monitor plant health and water quality parameters so that timely intervention and better maintenance practices can be applied. A key concern with large-scale phytoremediation is the disposal of harvested biomass, as plants accumulate heavy metals and other pollutants. Improper disposal can lead to secondary pollution, negating the benefits of phytoremediation. Researchers have proposed sustainable biomass utilization techniques such as biochar production, composting, and biofuel generation to manage harvested plant material in an environmentally friendly manner. These methods not only avoid waste buildup but also help in circular economy concepts.

Another drawback of phytoremediation with Canna indica and Colocasia esculenta is that they take relatively long times to remove the contaminant compared to traditional wastewater treatment technologies. Although phytoremediation is sustainable and economical, it might take longer times to attain desirable water quality requirements. To speed up pollutant removal, scientists have integrated phytoremediation with other treatment processes, including electrocoagulation, constructed wetlands with aeration, and the addition of pollutant-degrading microorganisms. Land availability is another problem, especially in cities where limited space could prevent the setup of extensive-scale phytoremediation wetlands. In addressing this issue, novel alternatives like vertical hydroponic phytoremediation systems and floating wetland islands have emerged. These systems optimize land use efficiency and yet utilize the phytoremediation capability of Canna indica and Colocasia esculenta. Although there are various challenges to applying phytoremediation with Canna indica and Colocasia esculenta, technology and sustainable management have eased these constraints. Through the amalgamation of plant-microbe interactions, controlled environments, computerized monitoring, sustainable biomass production, and hybrid treatment systems, phytoremediation grows as a functional and efficient tool for wastewater remediation. Improved research and ingenuity will better improve the scale and efficiency of this nature-centered method, hence becoming an essential part of upcoming

III. CONCLUSION

Employment of Canna indica and Colocasia esculenta in phytoremediation is an environmentally and eco-friendly method of wastewater treatment. Their capacity to uptake and eliminate contaminants such as heavy metals, organic pollutants, and surplus nutrients for their own growth and development makes them useful in inhibiting water contamination, especially with regard to domestic, industrial, and urban wastewater treatment. One of the greatest advantages of such plants in phytoremediation is that they have highly developed root systems, which help increase pollutant uptake and microbial activity. With mechanisms such as rhizofiltration and phytoextraction, such plants are very important in removing harmful contaminants and enhancing water quality. Moreover, their ability to thrive in a wide range of environmental conditions means that they can be used both in constructed wetlands and in floating treatment wetland systems. In addition, Canna indica and Colocasia esculenta provide cost savings since phytoremediation is less costly to operate compared to traditional methods of wastewater treatment. With minimal care, they can grow in contaminated water bodies, which provides them with an economic appeal as a viable option for decentralized treatment systems, especially in low-resource areas. Despite their numerous advantages, challenges remain in fully optimizing the use of these plants in large-scale wastewater treatment. Factors such as seasonal variations, pollutant tolerance limits, and biomass disposal need to be effectively managed to ensure sustainable phytoremediation implementation. Future research should focus on enhancing plant resilience to extreme pollution conditions, integrating phytoremediation with other wastewater treatment technologies, and improving biomass management strategies. Furthermore, developments in plant-microbe interactions may serve to further enhance the phytoremediation efficacy of these species. The addition of beneficial microbial communities to the root system of Canna indica and Colocasia esculenta can greatly enhance pollutant degradation, making the overall process more efficient. The scalability of phytoremediation with these plants also relies on land availability and design enhancement in wetland treatment systems. Advances like vertical hydroponic phytoremediation and floating wetland islands may offer space-saving solutions for urban wastewater treatment, broadening the applicability of this method. In summary, Canna indica and Colocasia esculenta are of great potential as natural, inexpensive, and environmentally friendly alternatives for wastewater treatment. With further research, technological innovations, and policy incentives, phytoremediation with these plants can become an important component in enhancing water quality, minimizing environmental pollution, and facilitating sustainable resource management. Future initiatives must aim to integrate these systems into larger wastewater treatment systems, thereby guaranteeing their long-term sustainability in environmental protection and public health.

REFERENCES

[1]. Chavan, P.V., et al. (2021). "Removal of Oil and Grease from Greywater Using Colocasia esculenta." Water Environment Research, 93(5), 980-990

[2]. Kumar, S., et al. (2019). "Economic Feasibility of Phytoremediation for Wastewater Treatment Using Wetland Plants." Water Science and Technology, 80(7), 1345-1356.

[3]. Li, X., et al. (2021). "Long-term Efficiency of Canna indica and Colocasia esculenta in Tropical Constructed Wetlands." Ecological Engineering, 158, 106089.

[4]. Oustriere, N., et al. (2017). "Heavy Metal Phytoremediation Potential of Colocasia esculenta in Contaminated Water." Journal of Environmental Management, 204, 326-334.

[5]. Patel, R., et al. (2022). "Comparative Study of Wetland Plants for Domestic Wastewater Treatment." Journal of Water Sustainability, 12(1), 45-59.

[6]. Rahman, M.M., et al. (2020). "Microbial Interactions in Constructed Wetlands: Role of Canna indica in Organic Pollutant Degradation." Environmental Pollution, 265, 114915.

[7]. Sharma, D., et al. (2023). "Hybrid Treatment Systems for Kitchen Wastewater: Integrating

[8]. Abioye, O.P., et al. (2019). "Phytoremediation of Emerging Contaminants Using Colocasia esculenta." Environmental Research, 47(2), 298-312.

[9]. Ghosh, P., et al. (2022). "Utilization of Canna indica in Floating Wetlands for Urban Water Restoration." Water Science and Technology, 86(5), 1023-1035.

[10]. Kumar, S., et al. (2021). "Hybrid Wetland Systems Using Canna indica and Colocasia esculenta for Construction Wastewater Treatment." Journal of Environmental Engineering, 147(6), 04021033.

[11]. Li, X., et al. (2018). "Performance of Canna indica in Constructed Wetlands Treating Urban Wastewater." Ecological Engineering, 125, 100-112.

[12]. Li, Y., et al. (2021). "Economic Feasibility of Phytoremediation in Decentralized Wastewater Treatment Systems." Water Resources Management, 35(4), 1598-1612.

[13]. Oustriere, N., et al. (2020). "Treatment of Cement Industry Wastewater Using Colocasia esculenta." Journal of Hazardous Materials, 388, 121943.

[14]. Wang, Y., et al. (2020). "The Role of Canna indica in Urban Stormwater Management." Environmental Pollution, 268, 115890.

[15]. Zhang, C., et al. (2019). "Heavy Metal Removal from Construction Wastewater Using Colocasia esculenta." Water Research, 152, 202-214.