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Design of Disinfection System for Septic Tank Overflow Water

Anamika Jayapradeep[1], Malavika Krishna Kumar[2], Sandra P[3], Sayoojya B V[4], Nivya T K[5]

[1,2,3,4] Department of Civil Engineering, College of engineering Thalassery/APJ Abdul Kalam Technological University, Kerala, India.

[5]Assistant Professor, Department of Civil Engineering, College of engineering Thalassery/APJ Abdul Kalam Technological University, Kerala, India.

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Abstract: *Access to clean drinking water is a fundamental human right, yet millions worldwide lack access to safe and portable water. Waterborne pathogens like E. coli and fecal coliform pose significant health risks. In this project we develop a disinfection dosage system using neem (Azadirachta indica) extract to treat septic tank over flow water, rich in pathogens and contaminants which cause surface water and ground water contamination. Our system leverages neem extract's antimicrobial properties, demonstrated through membrane filtration tests, which show significant microbial load reduction. This innovative approach offers a sustainable, effective, and eco-friendly solution for treating septic tank overflow water, promoting public health and mitigating waterborne diseases.*

I.INTRODUCTION

Access to clean drinking water is a fundamental human right, essential for human survival, health, and well-being. However, millions of people worldwide lack access to safe and potable water, leading to a significant burden of waterborne diseases. According to the World Health Organization (WHO), approximately 844 million people globally lack access to improved water sources, and 2.3 billion people lack access to basic sanitation facilities (WHO, 2019). This has resulted in a staggering number of waterborne disease outbreaks, with millions of people suffering from illnesses such as cholera, typhoid fever, and diarrhea. Waterborne pathogens, including bacteria, viruses, and parasites, pose significant health risks to humans. These pathogens can contaminate water sources through various means, including human waste, agricultural runoff, and industrial effluent. In particular, septic tank overflow water is a significant source of water borne pathogens, as it can contain high levels of fecal coliforms, E. coli, and other microorganisms. When left untreated, septic tank overflow water can contaminate surface water and groundwater, posing a significant risk to public health. Traditional water treatment methods, such as chlorination and ozonation, have been effective in reducing waterborne diseases. However, these methods have several limitations, including the formation of harmful byproducts, high operational costs, and the potential for the development of disinfectant-resistant pathogens. Furthermore, these methods may not be suitable for treating septic tank overflow water, which requires specialized treatment due to its high pathogen load. In recent years, there has been a growing interest in the use of natural disinfectants for water treatment. Neem extract, derived from the seeds of the neem tree (Azadirachta indica), has been shown to exhibit antimicrobial properties against a wide range of waterborne pathogens. Neem extract has been used for centuries in traditional medicine and has been shown to be safe for human consumption. Its use as a natural disinfectant for water treatment has the potential to provide a sustainable, effective, and eco-friendly solution for treating septic tank overflow water. This project aims to develop a disinfection dosage system using neem extract to treat septic tank overflow water. The system will leverage neem extract's antimicrobial properties, demonstrated through membrane filtration tests, to significantly reduce microbial loads. This innovative approach offers a promising solution for promoting public health and mitigating waterborne diseases, particularly in areas where access to safe and potable water is limited.

II. MATERIAL AND METHODS

The study begins with area selection, identifying locations where septic tank water contamination poses a risk to groundwater. Initial microbial testing is conducted to determine coliform levels in the contaminated water. Neem extract is prepared using neem powder and ethanol and an extra tank fitting (dorsal tank) is installed before the soak pit to disinfect septic tank water. A model of the septic tank system is designed, incorporating the septic tank, dorsal tank (for neem extract disinfection), and soak pit to demonstrate the treatment process. Water samples are analyzed before and after treatment, and microbial analysis is conducted to confirm the efficiency of neem extract in reducing bacterial contamination before groundwater recharge. The methodology of our project consist of several stages.

Selection And Study of Area: In densely populated residential areas, coliform testing focuses on locations where water, food, sanitation system and envinormental factors increase the risk of contamination. Reports of water borne diseases indicate possible contamination. The selection of a study area is crucial in investigating the microbial quality of well water, as it enables the identification of potential contamination sources and informs the development of effective mitigation strategies. To ensure the relevance and applicability of the research findings, it is essential to choose an area with a high risk of water contamination. Based on a survey conducted and information obtained from the municipality, Kayath (Ward 48) in Thalassery was identified as a high-risk area for water contamination and therefore, was selected as the study area for this research.

Collection of Water Sample: In this phase, after conducting a thorough literature survey, we decided on the exact sampling points for collecting water samples from different wells in Kayath. Based on the survey, we selected sampling points from various wells to ensure a representative analysis of water quality. We collected a total of water samples from different wells for coliform analysis, with each sample carefully collected and handled to minimize contamination and ensure accurate results. The sampling process involved the use of sterilized sample bottles to prevent contamination, collection of water from the mid depth of each well using a clean, pre-sterilized container to represent the overall water quality, and meticulous labeling of each sample bottle with date, time, and location details to ensure traceability and data organization. Furthermore, the samples were promptly transported to the laboratory within 6 hours of collection. This ensured the accuracy and reliability of the analysis results, providing a comprehensive understanding of the water quality in the selected wells.

Coliform Bacteria Analysis in Well Water Samples: Coliform bacteria analysis was conducted on the well water samples to assess the microbiological quality of the groundwater. Specifically, tests for Total Coliform (TC) and Fecal Coliform (FC) were performed using the membrane filtration procedure. This procedure involves passing a measured volume of water through a sterile membrane filter, which captures the bacteria present in the sample. The filter is then incubated on a selective medium that promotes the growth of coliform bacteria, allowing for the detection and enumeration of these microorganisms. The presence of Total Coliform bacteria indicates potential contamination of the water source, while Fecal Coliform bacteria are more specific indicators of fecal contamination, suggesting the presence of pathogens that can pose health risks to consumers. The results of these tests provide valuable insights into the safety and quality of the well water, informing measures to ensure the protection of public health.

Design of Septic Tank: A septic tank is an underground, watertight chamber designed to treat and dispose of household wastewater through biological decomposition and sedimentation. The design of a septic tank is tailored to meet the specific needs of a household, taking into account the number of users, wastewater flow rate, and treatment capacity. A properly designed septic tank provides a safe and effective way to manage household wastewater, protecting public health and the environment. It works by separating solids from liquids, breaking down organic matter, and allowing treated wastewater to discharge into the soil. Regular maintenance and inspection ensure the longevity and efficiency of the septic tank, preventing system failures and environmental contamination.

Experimental Sample Preparation: For the purpose of this study, cow dung wastewater was chosen as a substitute for septic tank water due to its accessibility and ease of handling. The challenges of collecting and managing septic tank water, including potential health risks, made it impractical. In contrast, cow dung wastewater offers a safer and more convenient alternative. This approach is also supported by Indian standard codes, including IS 3306:2010, IS 2470:1999, and IS 16098:2013, which provide guidelines for septage management and safety protocols. By using a controlled mixture of cow dung and water, this study aims to efficiently assess disinfection efficiency under controlled laboratory conditions.

Neem Extract Formulation for Wastewater Treatment: Neem extract plays a crucial role in enhancing the efficacy of wastewater treatment systems, particularly in rural or decentralized settings where access to conventional treatment technologies is limited. The extract is prepared using neem powder dissolved in ethanol, in accordance with the Indian Standard (IS) 10500:2012 guidelines for septic tank water disinfection. This natural, sustainable, and environmentally friendly approach enables effective removal of pathogens, bacteria, and other microorganisms, ensuring the safety and quality of water resources.

Addition of Neem Extract: The neem extract was carefully added to the water sample in varying concentrations to achieve optimal disinfection and purification. Different volumes of the extract were added to create distinct concentrations, enabling a comprehensive analysis of its effects. To ensure effective treatment, the addition of neem extract was calibrated, considering its potential antimicrobial and antifungal properties. The resulting mixtures were then subjected to further analysis to assess the efficacy of the neem extract in improving the overall quality of the water sample and to determine the optimal concentration for achieving the desired outcome.

Evaluation of Efficiency: In this phase, the efficiency of the neem extract in reducing coliform bacteria in the water samples was evaluated. The analysis focused on determining the reduction in coliform bacteria counts after treatment with neem extract. The acceptable limit and permissible limit of coliform bacteria were referenced from IS 10500:2012 (SECOND REVISION) to assess the efficacy of the neem extract treatment. The results provided insight into the efficiency of the neem extract in reducing coliform bacteria, thereby evaluating its potential as a natural water treatment agent.

Optimisation Of Neem Extract Concentration: The optimization of neem extract dosage was crucial to achieve maximum efficacy in reducing coliform bacteria from the water samples. Based on the acceptable limit and permissible limit of coliform bacteria as per IS 10500:2012 (SECOND REVISION), the optimal dosage of neem extract was determined. The results showed that the optimized dosage of neem extract effectively reduced the coliform bacteria count, thereby improving the water quality. Furthermore, we can optimize the concentration of neem extract to determine the most suitable dosage for the disinfection of wastewater, particularly in septic tank wastewater, ensuring a significant reduction in pathogens and pollutants, and promoting a sustainable and eco-friendly approach to wastewater management.

Comparison Of Efficiency: A comparative analysis was conducted to evaluate the efficiency of neem extract and chlorine as disinfectants in reducing coliform bacteria from wastewater. The aim of this comparison was to assess the effectiveness of neem extract as a natural and eco-friendly alternative to chlorine, a commonly used chemical disinfectant. By comparing the disinfection capabilities of neem extract and chlorine, this study sought to determine which method provides superior results in terms of reducing microbial contaminants and improving water quality.

Experimental Procedures and Techniques

Initial Microbiological Assessment Of Well Water: The initial microbiological assessment of well water was conducted to determine the presence and abundance of microorganisms, particularly total coliform and fecal coliform bacteria. This assessment provided a baseline understanding of the water quality prior to treatment. Water samples were collected from the well and analyzed using standardized microbiological methods. Testing for total and fecal coliform bacteria is a crucial process in assessing water quality, particularly for drinking water, recreational water, and wastewater, as it helps determine potential contamination by harmful microorganisms and the effectiveness of water treatment processes.

Total Coliform: Total coliform is a group of Gram-negative, rod-shaped bacteria that belong to the family Enterobacteriaceae. They are commonly found in the environment, soil, and intestines of animals, and are typically harmless. However, their presence in water can indicate potential contamination with other harmful microorganisms, such as pathogens. Physically, total coliform bacteria are rod-shaped, typically 2-4 μm in length and 0.5-1.0 μm in width, with a thin peptidoglycan layer and peritrichous flagella that enable motility. They are facultative anaerobes, able to grow in the presence or absence of oxygen.

Experimental Procedure for Determination of Total Coliform in Water: The total coliform testing experiment is a microbiological procedure used to detect coliform bacteria in water samples, ensuring water quality and safety. The test utilizes MEndo Agar as the selective growth medium, along with essential laboratory equipment such as filtration apparatus, 0.45-micrometer microcellulose filters, Petri dishes, and sterile forceps. Before beginning, all equipment must be sterilized at 121°C for 15 minutes to prevent contamination. The preparation of MEndo Agar involves suspending 5.105g of the medium in 98 ml of distilled water, heating until fully dissolved, and then cooling to 45–50°C before adding 2 ml of 95% ethanol. The prepared medium is poured into 80 mm Petri dishes, allowed to solidify, and protected from direct sunlight to maintain stability. For the procedure, a sterile filtration unit is used to prevent contamination. A sterile membrane filter is carefully placed on the porous base of the filtration apparatus using sterile forceps, followed by the assembly of the matched funnel unit. The water sample is thoroughly mixed by vigorous shaking to disperse bacterial clumps before 50 ml of the sample is poured into the filtration chamber. After filtration, the funnel is unlocked, and the membrane filter is carefully removed using sterile forceps. The filter is then placed onto the prepared MEndo Agar medium, ensuring even contact. Each Petri dish contains only one membrane filter. The plates are inverted and incubated at 35 ± 0.5°C for 22–24 hours, allowing bacterial growth. Between samples, the funnels are sanitized, and all cleaned equipment is exposed to UV radiation for two minutes to eliminate any remaining contaminants. Following incubation, bacterial colonies are examined. Typical coliform colonies on MEndo Agar appear pink to dark red with a metallic surface sheen, indicating the presence of coliform bacteria. Some atypical coliform colonies may also appear as dark red, mucoid, or nucleated without sheen. The final count of coliform colonies determines the level of contamination in the water sample. This method is essential in water quality assessment, as coliform presence serves as an indicator of potential fecal contamination and overall water safety.

Fecal Coliform: Fecal coliform is a subgroup of total coliform bacteria that is specifically found in the feces of warm-blooded animals. They are typically thermotolerant, able to grow at elevated temperatures above 44°C (111°F). Fecal coliform bacteria are also rod-shaped, with similar physical characteristics to total coliform bacteria. However, their ability to grow at higher temperatures distinguishes them from other types of coliform bacteria. The presence of fecal coliform in water is a strong indicator of fecal contamination and potential health risks.

Experimental Procedure for Determination of Fecal Coliform in Water: The thermotolerant (fecal) coliform membrane filter procedure is a microbiological method used to detect fecal contamination in water samples. This test employs mFC Medium, a selective growth medium, and requires laboratory equipment such as sterile sample bottles, dilution bottles, pipets, graduated cylinders, and containers for the culture medium. Water samples are collected in sterile containers and stored at 4°C to prevent bacterial growth until analysis, which must be conducted within six hours to ensure accuracy. The filtration setup is assembled and sterilized before use to avoid cross-contamination. A sterile 0.45 μm membrane filter is placed onto the filtration apparatus, and a measured volume of the water sample—typically 100 ml—is filtered under vacuum pressure. This process captures bacteria present in the sample on the filter surface. After filtration, the membrane filter is carefully transferred onto a pre-prepared mFC agar plate using sterile forceps, ensuring full contact with the medium. The plates are then inverted and incubated at 44.5°C ± 0.2°C for 24 hours, a temperature that selectively promotes the growth of fecal coliforms while inhibiting non-fecal bacteria. After incubation, colonies are examined, with thermotolerant (fecal) coliforms appearing as distinct blue colonies on the mFC medium. The results are expressed in colony-forming units per 100 ml (CFU/100 ml), providing a quantitative assessment of fecal contamination in the water sample. To ensure the accuracy and reliability of the results, positive and negative controls are run alongside the test, and further biochemical tests may be performed if necessary. This method is widely used in water quality monitoring to detect fecal contamination in various water sources, including drinking water, recreational water, and wastewater. The presence of thermotolerant coliforms indicates potential contamination by human or animal waste, posing a risk to public health. Therefore, this test is essential for regulatory compliance, environmental protection, and safeguarding public health by ensuring that water sources meet microbiological safety standards.

Neem Extraction: Neem extraction refers to the process of obtaining bioactive compounds, such as azadirachtin, flavonoids, and tannins, from Neem leaves or powder using a solvent, typically ethanol. This process involves a series of steps, including drying and processing Neem leaves or powder, mixing with ethanol, soaking, and filtering, to produce a concentrated extract. Neem extraction is crucial for the development of a disinfection system using natural disinfectants, as it enables the utilization of Neem's antimicrobial properties to inactivate microorganisms, improve water quality, provide a sustainable alternative to chemical disinfectants, and enhance public health. The development of a disinfection system using Neem extract can contribute to improved public health outcomes, particularly in communities with limited access to safe drinking water, by offering a natural, biodegradable, and non-toxic solution for water treatment.

Preparation Of Neem Extract: The experiment involves the preparation of a neem extract using either fresh neem leaves or dried neem powder and ethanol as the solvent. The process begins with drying the neem leaves, which can be done through sun drying. In this traditional method, the leaves are spread thinly on a clean surface in a well-ventilated and shaded area to prevent degradation of active compounds due to direct sunlight. The drying process takes approximately 5 to 10 days, depending on humidity levels. Once dried, the neem leaves are crushed into small pieces or ground into a fine powder to facilitate storage. These dried neem leaves or powder are then stored in an airtight container, such as a glass jar or a sealed plastic bag, in a cool, dark, and dry place to prevent moisture absorption and maintain their potency for up to 6 to 12 months. To prepare the neem extract, a specific ratio of neem leaves to ethanol is used, typically 1:5 (w/v), meaning one part neem leaves to five parts ethanol by weight to volume. In this experiment, for the preparation of 1 liter (1000 mL) of neem extract, 200 grams of dried neem leaves are measured and mixed with 1000 mL (1 liter) of ethanol. This allows for an effective extraction of bioactive compounds from the neem leaves into the ethanol solvent. Ethanol is chosen as the solvent due to its high efficiency in extracting active phytochemicals, including azadirachtin, flavonoids, and tannins, which are responsible for neem’s medicinal and insecticidal properties. The resulting solution was transferred to a clean, sterile container and left to settle for 24 hours, allowing for stabilization and reducing the likelihood of clogging during filtration. The filtration process was performed using Whatman Grade 1 filter paper, which was specifically selected for its efficiency in removing unwanted particulates and ensuring a high-purity extract. The resulting neem extract can then be stored in a clean, airtight container for future use in various applications such as pest control, antimicrobial treatments, or medicinal formulations. Neem powder, prepared neem extract using ethanol and neem extract filtration using filter paper is shown in fig .1.

Fig .1. Neem powder, prepared neem extract using ethanol and neem extract filtration using filter paper

Experimental Sample Preparation: In this experiment, cow dung wastewater is used as a substitute for septic tank water due to its ease of access, convenience, and ability to provide a controlled experimental setup. Handling septic tank water presents significant logistical and safety challenges, including difficulty in collection, contamination risks, and potential health hazards. On the other hand, cow dung mixed with water serves as a suitable alternative, offering similar microbial contamination as septic tank water, while ensuring a safe and standardized approach for evaluating disinfection efficiency. The preparation of the wastewater sample begins with the collection of 10 grams of fresh cow dung, which is mixed with 1 liter of clean water in a sterile container. This ratio is carefully chosen to maintain a microbial load comparable to the contamination levels typically found in actual wastewater. The cow dung-water mixture is stirred continuously for 10 to 15 minutes to ensure that the bacteria and organic matter are evenly distributed throughout the solution. Thorough mixing is crucial because it ensures homogeneity, preventing variations in bacterial concentration that could affect the reliability of disinfection tests. If the solution is not mixed properly, there could be inconsistencies in microbial load across different portions of the sample, potentially distorting the results of the experiment. Once mixed, the sample is left undisturbed for 1 to 2 hours at room temperature, typically between 25-30°C. This resting period allows the bacterial activity to stabilize, ensuring that the microbial population is consistent throughout the sample. The stabilization process minimizes any immediate fluctuations in microbial growth caused by the mixing process, which is important for ensuring the accuracy of the disinfection tests. The goal is to create a uniform microbial environment that reflects the contamination typically found in wastewater, providing a reliable baseline for testing the disinfection capabilities of neem extract. After the resting period, the wastewater sample is divided into 100 mL portions, each of which will be used to test the effectiveness of various concentrations of neem extract as a disinfectant. This division allows for multiple trials and comparisons under controlled conditions, ensuring that each test can be performed with precision. Handling the sample in smaller portions also allows for the possibility of replication, which is vital for validating the results and drawing consistent conclusions about the disinfection potential of neem extract. Throughout the entire process, great care is taken to handle and store the samples properly, ensuring that external contamination is avoided. Proper sterilization of containers, utensils, and workspaces is critical to prevent introducing foreign microbes, which could interfere with the experiment's integrity. The prepared sample using cow dung is shown in Fig 4.2. This careful and methodical approach ensures that the study produces accurate and reproducible results. By mimicking the microbial contamination found in real wastewater and evaluating the disinfection efficiency of neem extract in a controlled manner, the experiment offers valuable insights into the potential of neem as a disinfectant in wastewater treatment. The results could contribute to the development of more accessible and effective sanitation solutions, particularly in areas where septic systems or conventional wastewater treatment methods are not available or reliable.

Fig .2 prepared sample using cow dung

Treatment of Simulated Septic Tank Water Sample: The treatment of simulated septic tank water samples was carried out using neem extract, which was meticulously prepared through an optimized extraction process. The neem extract was obtained using ethanol as the solvent, chosen for its high efficiency in extracting bioactive compounds such as azadirachtin, nimbin, and salannin, which are known for their antimicrobial and antifungal properties. The preparation process ensured that the extract retained its maximum potency for effective application in treating the simulated septic tank water samples. Neem leaves were sourced from a reputable supplier, ensuring high quality and freshness. The leaves had a moisture content of less than 10%, which was crucial for effective drying and extraction. Initially, the neem leaves underwent a sun-drying process for seven days under controlled environmental conditions. This step was closely monitored to prevent excessive loss of essential bioactive compounds and to eliminate the risk of microbial contamination. After drying, the neem leaves were ground into a fine powder using a grinder to enhance surface area exposure and facilitate the extraction process. The powdered neem leaves were then subjected to solvent extraction using ethanol, which was carefully measured and added to ensure optimal dissolution of the active constituents. The extraction process was carried out at room temperature (25-30°C) to preserve the integrity of the bioactive compounds. The resulting solution was transferred to a clean, sterile container and left to settle for 24 hours, allowing for stabilization and reducing the likelihood of clogging during filtration. The filtration process was performed using Whatman Grade 1 filter paper, which was specifically selected for its efficiency in removing unwanted particulates and ensuring a high-purity extract. After filtration, the neem extract was collected and divided into 100 ml portions, with each portion allocated for different concentration levels to assess the efficacy of the extract in treating the septic tank water samples. To evaluate the impact of neem extract on the treatment of simulated septic tank water samples, the extract was added at varying concentrations of 10 ml, 20 ml, 30 ml, and 40 ml per 100 ml of the sample. Each concentration was prepared in separate conical flasks to systematically analyze the effect of different neem extract levels on microbial reduction and overall water quality improvement. This systematic approach enabled us to determine the optimal concentration for achieving the desired outcome, including improved antimicrobial activity, enhanced antioxidant properties, or increased efficacy in controlling pests and diseases.

Final Microbiological Analysis of Treated Septic Tank Water Samples: In this experiment of the final microbiological analysis, total coliform and fecal coliform testing was conducted to assess the effectiveness of the treatment process in removing microbial contaminants from the septic tank water samples. The objective of this test was to determine the presence and abundance of total coliform and fecal coliform bacteria in the treated septic tank water samples. The test was conducted using the membrane filter technique, which involved passing a measured volume of the treated septic tank water sample through a sterile membrane filter, then placing the filter on a selective growth medium, and incubating at a controlled temperature. This procedure is similar to the initial microbiological analysis of total and fecal coliform (Section 4.1), with the key difference being the sample type used - in this case, treated septic tank water samples were used, whereas well water samples were analyzed in the initial stage.

Disinfection Of Sample Water Using Liquid Chlorine: This procedure is similar to the initial microbiological analysis described in Section 4.1, with the key difference being that the sample is treated with liquid chlorine (sodium hypochlorite) to disinfect the wastewater. Four equal portions of 100 mL each of cow dung wastewater were taken and transferred into separate sterile conical flasks. Sodium hypochlorite (liquid chlorine, 5% available chlorine) was added in increasing volumes: 1 mL to the first flask, 2 mL to the second, 3 mL to the third, and 4 mL to the fourth. The samples were thoroughly mixed to ensure even distribution of chlorine and were left to react for 30-60 minutes to allow effective disinfection. After the contact period, the treated samples were left undisturbed for 24 hours to observe any further effects of chlorine over time. Following this period, the samples were analyzed using the membrane filtration method to detect fecal coliforms and total coliforms. Each sample was filtered through a membrane, which was then placed on a selective growth medium and incubated under controlled conditions. The bacterial colonies that developed were counted and compared to determine the effectiveness of different chlorine dosages over time.

Design And Prototype Development of Septic Tank Disinfection System Based on Standard Calculations and Autocad Drafting

General: Septic tank systems are a crucial component of decentralized wastewater treatment, providing a safe and effective means of managing domestic sewage. The design of these systems is critical to ensuring efficient treatment, preventing environmental pollution, and protecting public health. A well-designed septic tank system must take into account various factors, including hydraulic loading, organic loading, soil characteristics, and climate. Furthermore, the design must also consider the potential risks associated with septic tank systems, such as groundwater contamination and surface water pollution. Standard calculations play a vital role in septic tank system design, enabling engineers to determine the optimal tank size, shape, and configuration. These calculations are based on established guidelines and regulations, ensuring that the designed system meets the required treatment standards. By using standard calculations, engineers can determine the required treatment capacity, calculate the optimal tank size and configuration, and ensure compliance with regulatory requirements. AutoCAD drafting is an essential tool in septic tank system design, allowing engineers to create accurate and detailed designs. AutoCAD enables the creation of 2D and 3D models, facilitating the visualization and analysis of the designed system. This helps to identify potential design flaws and optimize the system's performance, communicate the design effectively to stakeholders, and ensure accurate construction and installation.

Standard Calculations for Septic Tank System Design: A septic tank is an underground, watertight chamber used for the treatment and disposal of household wastewater. It is commonly made of concrete, fiberglass, or plastic and is designed to allow the separation and breakdown of solid and liquid waste through natural biological processes. The design of a septic tank depends on several factors, including the number of users, daily wastewater flow rate, and soil conditions. Typically, the tank has two compartments: the first chamber allows heavier solids to settle at the bottom as sludge, while lighter materials like grease and oil float to the top as scum. The partially treated effluent then flows into the second chamber, where further settlement occurs before it is discharged into a drain field for final treatment and absorption into the soil. Bacteria present in the tank help decompose organic matter, reducing the volume of solid waste over time. Proper design, regular maintenance, and suitable soil permeability are essential to ensure efficient operation, prevent blockages, and avoid groundwater contamination. Septic tanks are widely used in rural and suburban areas where centralized sewage systems are unavailable, offering a cost effective and environmentally friendly wastewater management solution. In this design, we will outline the steps for designing a septic tank system for a small household with five users. The design will be based on Indian standards (IS 2470:1994) and will take into account the specific water consumption patterns, wastewater flow rates, and site conditions. The goal of this design is to provide a functional and efficient septic tank system that meets the needs of the household while minimizing environmental impacts. This design considers the water consumption patterns, wastewater flow rates, and site conditions to provide a reliable and efficient septic tank system. The design involves calculating wastewater flow rates and volumes, determining septic tank size and configuration, selecting suitable materials, designing the drainage system, and considering safety features.

Autocad Drafting of Septic Tank Disinfection System: AutoCAD is a powerful computer-aided design (CAD) software that enables precise drafting and detailing, making it an essential tool for designing a septic tank disinfection system in 2D. The process begins by launching AutoCAD and setting up the drawing environment, where users define units, layers, and line types to maintain organization and accuracy. The 2D design starts with outlining the septic tank disinfection system using basic drawing tools such as LINE, RECTANGLE, and CIRCLE to represent the system's structure, inlet and outlet pipes, baffles, and other components. Commands like OFFSET help create uniform wall thickness, while FILLET and TRIM refine intersections and connections between different elements. To enhance readability and ensure precision, DIMENSION tools are used to label measurements, and ANNOTATE tools help in adding text descriptions for clarity. A well-structured septic tank disinfection system layout includes separate layers for different components, such as the tank, pipes, and disinfection units, which can be managed through the LAYER PROPERTIES tool. This ensures that each part of the system is visually distinct, allowing for easy modifications and updates. Additionally, the HATCH command is used to apply different patterns to materials like concrete walls or soil, improving visual differentiation. By using BLOCKS, repetitive components such as manholes, vents, or pipe fittings can be inserted efficiently without redrawing them multiple times. AutoCAD's precision tools, including OBJECT SNAP (OSNAP) and GRID, assist in aligning elements accurately, preventing errors in placement. The final step in 2D drafting is generating a well-documented layout with detailed construction drawings, including sectional views and pipe flow directions. These drawings are typically formatted using LAYOUT and PLOT commands to prepare them for printing or exporting in formats like DWG and PDF for use in construction and approval processes. A 2D model of a septic tank disinfection system using AutoCAD is a digital representation of the system's design, created using AutoCAD software. It's called "2D" because it shows the system's components and layout in two dimensions, like a blueprint or a technical drawing.This type of model is useful for designing, planning, and visualizing the septic tank disinfection system, as well as for communicating the design to others. It can include dimensions, annotations, and other details to help ensure that the system is built correctly. In essence, a 2D model of a septic tank disinfection system using AutoCAD is a detailed, digital drawing that shows how the system's components fit together and how they'll be laid out on the site. By utilizing AutoCAD's advanced 2D drafting features, designers can create a highly accurate and detailed septic tank disinfection system plan that ensures efficiency, compliance, and ease of implementation. The Fig 1.1. shows the AutoCAD model of the septic tank disinfection system.

Prototype Development of a Septic Tank Disinfection System: In this prototype model, we have developed a comprehensive septic tank disinfection system that addresses the critical issue of wastewater treatment. The system consists of a septic tank, a dosing tank, a collection tank, and a sockpit. Wastewater from the septic tank flows into the collection tank, where it is treated with neem extract from the dosing tank. The neem extract is added to the collection tank water through a drip-by-drip process, allowing for a controlled and efficient treatment process. This innovative approach harnesses the natural disinfectant properties of neem to provide a reliable and environmentally friendly solution for septic tank wastewater treatment. Our team designed and developed this prototype model based on detailed AutoCAD drawings. The use of AutoCAD drawings enabled us to optimize the system's design, ensuring that it is efficient, cost-effective, and easy to operate. The system is designed to produce disinfected water that is suitable for groundwater recharge, thereby preventing contamination of the groundwater aquifer. Untreated septic tank water can pose a significant risk to groundwater quality, as it can contaminate the aquifer and affect the health of communities that rely on groundwater for drinking and other purposes. The dosing tank is a refillable container that allows for easy replenishment of the neem extract. To refill the dosing tank, the user simply needs to open the container cap, pour in the required amount of neem extract, and replace the cap. This straightforward refilling process ensures that the system remains operational and effective in treating wastewater, making it a convenient and practical solution for ongoing wastewater treatment. The treated water from the collection tank then flows into the sock pit, providing a safe and sustainable solution for wastewater disposal. By adopting this technology, we can promote a healthier environment, protect groundwater resources, and prevent waterborne diseases. Furthermore, the use of neem extract as a natural disinfectant provides a sustainable and eco-friendly solution that is cost-effective and easy to implement. The prototype of the septic tank disinfection system is shown in Fig 1.2. Additionally, the dosing tank, a key component of the system, is shown separately in Fig 1.3

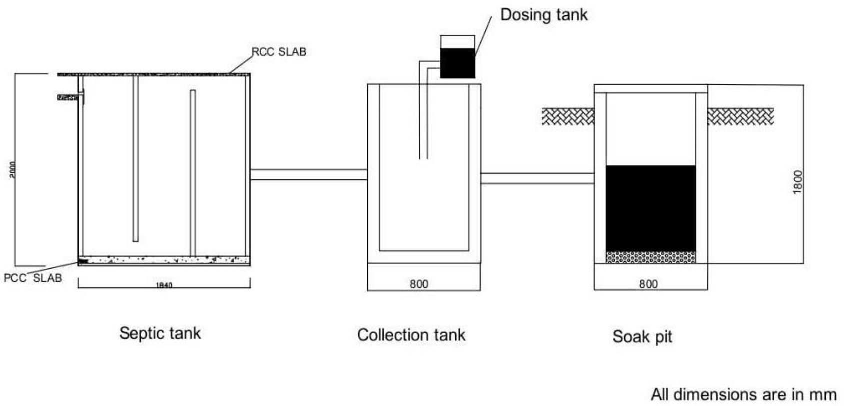


Fig 1.1. The AutoCAD model of the septic tank disinfection system

Fig 1.2. Prototype of Septic Tank Disinfection System

Fig.1.3. Detailed View of the Dosing Tank

III. RESULT AND DISCUSSION

Initial Microbiological Assessment Of Well Water: The initial microbiological analysis involved collecting 10 water samples from different wells in Kayath, using sterilized equipment and careful handling to minimize contamination. The samples were transported to the laboratory within 6 hours and analyzed for coliforms. The results showed that the water samples contained varying levels of total coliform and fecal coliform. Specifically, 6 samples tested positive for total coliform, with colony counts ranging from 36 to 68, and 4 samples tested positive for fecal coliform, with colony counts ranging from 26 to 42. The remaining samples tested negative for both total coliform and fecal coliform. The results of the water sample analysis before treatment are presented in Table 2.1.and graphically represented in Fig 2.1.

Sample No	Details	Total coliform (Present/Absent)	Fecal coliform (Present/Absent)
1	T.N. RABIYA	68	42
2	JAYAKRISHNAN	NIL	NIL
3	KADHISU	42	26
4	FATHIMA	NIL	NIL
5	NAZMI	36	NIL
6	FATHIMA	NIL	NIL
7	AFSALA	NIL	NIL
8	FATHIMA	46	NIL
9	V.VANAJA	52	26
10	KADHIJA	64	40

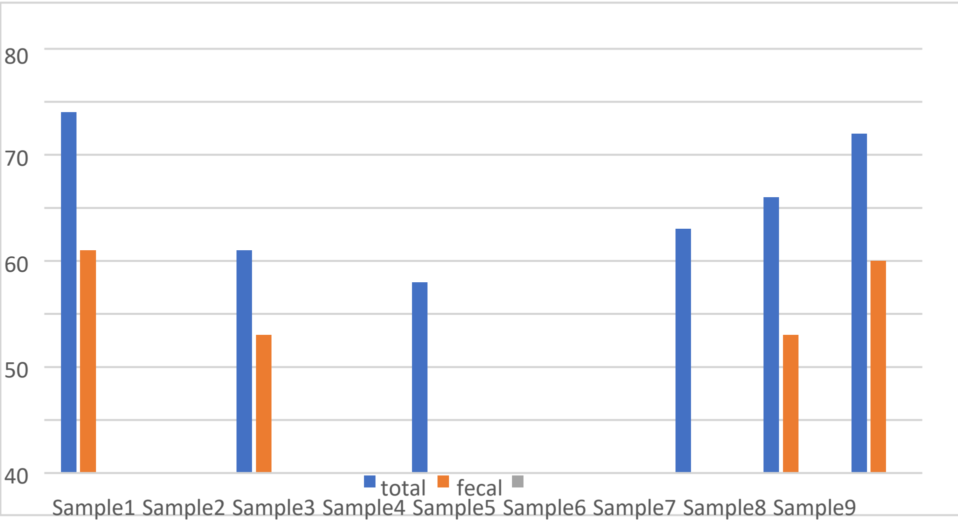


Fig 2.1 Initial microbiological testing for well water

Final Microbiological Analysis Of Treated Septic Tank Water Samples: The initial microbiological analysis of the septic tank water samples revealed extremely high levels of bacterial contamination, with results showing TNTC (too numerous to count) for total coliform and fecal coliform. Four samples were prepared for treatment, and after treatment with neem extract, the final microbiological analysis involved total coliform and fecal coliform testing to assess the effectiveness of the treatment process in removing microbial contaminants. Using the membrane filter technique, treated samples were analyzed to determine the presence and abundance of total coliform and fecal coliform bacteria. The results showed a gradual decrease in bacterial count with increasing neem extract concentration, with 10ml showing minimal disinfection, 20ml showing moderate reduction, 30ml showing 50% reduction, and 40ml showing 100% disinfection efficiency, completely eliminating total and fecal coliforms. The treatment effects of Neem extract on the samples were compared and presented in Figure 2.2. This figure shows the results of different treatment volumes, including the before treatment sample (A), and the samples treated with 10 mL (B), 20 mL (C), 30 mL (D), and 40 mL (E) of Neem extract. And the detailed results of these treatments are summarised in table 2.2. The graph of total coliform reduction using neem extract shown in fig 2.3. and the graph of fecal coliform reduction using neem extract shown in fig 2.4. The study demonstrated the effectiveness of neem extract in eliminating bacterial contaminants, with potential applications in household wastewater treatment.

Sample number	Details (Neem extract added)	Total coliform (Present/ Absent)	Fecal coliform (Present/Absent)
1	Before treatment	TNTC	TNTC
2	10ml	TNTC	TNTC
3	20ml	300	282
4	30ml	286	198
5	40ml	ABSENT	ABSENT

Table 2.2. Effectiveness of Neem Extract in Reducing Total Coliform and Fecal Coliform Bacteria

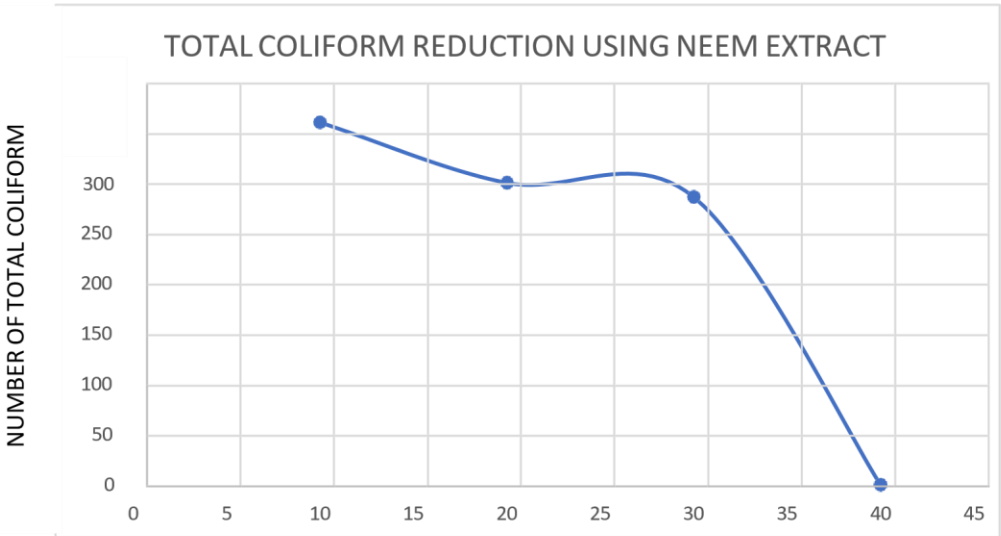


Fig 2.3. total coliform reduction using neem extract

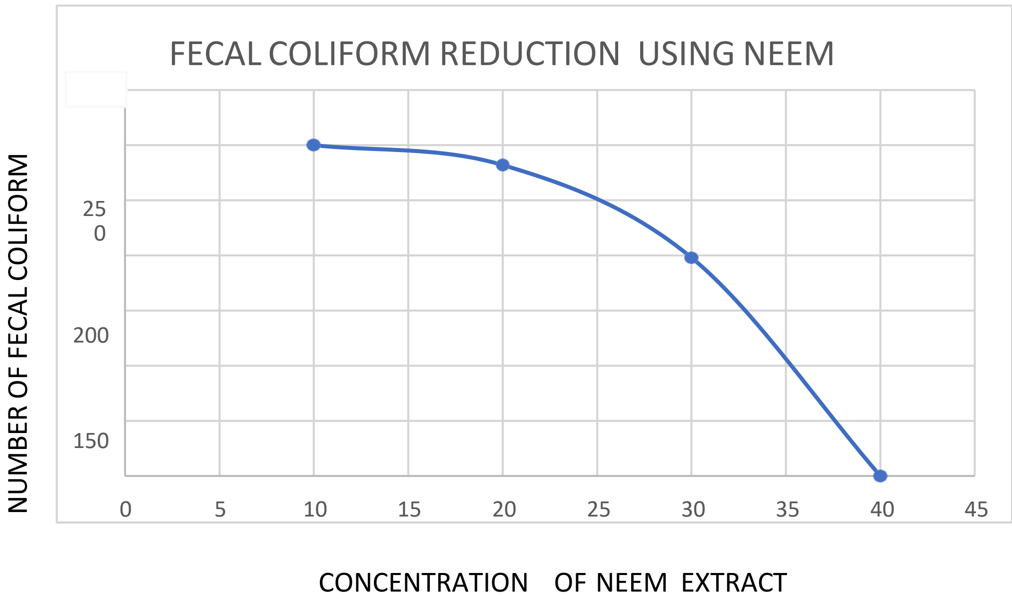
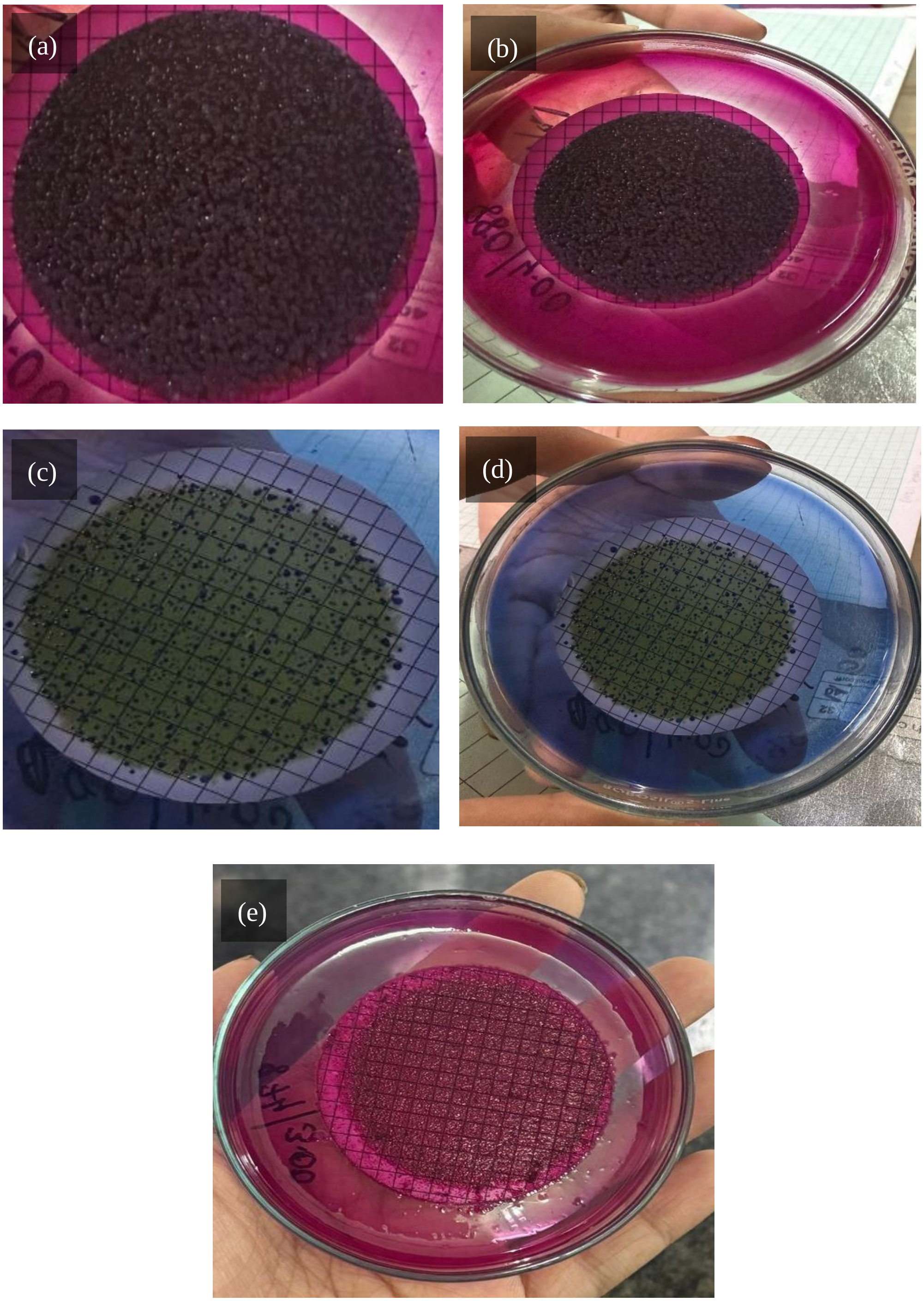


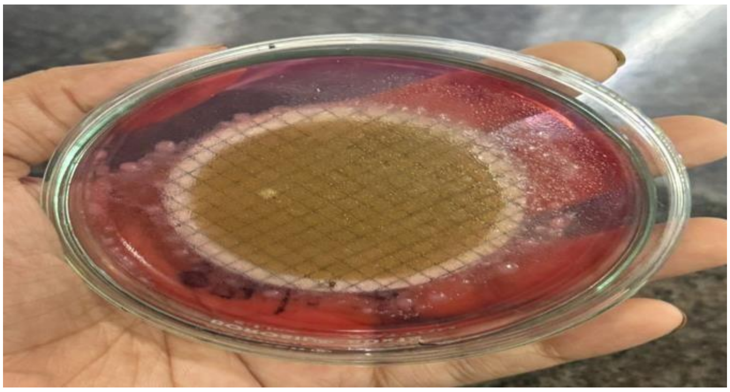
Fig 2.4. fecal coliform reduction using neem extract



Comparison of Treatment Effects Using Different Volumes of Neem Extract

(a). Before treatment (sampled)
(b). Treated sample using 10 mL of Name Extractor
(c). Treated sample using 20 mL of Name Extractor
(d). Treated sample using 30 mL of Name Extractor

Disinfection Of Sample Water Using Liquid Chlorine: The effectiveness of liquid chlorine in disinfecting wastewater samples was evaluated through total coliform and fecal coliform testing. The initial microbiological analysis revealed high levels of bacterial contamination, with results showing TNTC (too numerous to count) for total coliform and fecal coliform. Four samples were prepared by adding 1ml, 2ml, 3ml, and 4ml of liquid chlorine to each sample. The results showed that even at the lowest concentration of 1ml, the liquid chlorine was able to completely eliminate total and fecal coliform bacteria, achieving 100% disinfection efficiency. The detailed results of sample treated with liquid chlorine is shown in Fig 2.5. and Table 2.3 and the graph of total and fecal coliform deduction using chlorine is shown in Fig 2.6.



Laboratory result of sample treated with liquid chlorine

Sample number	Details (Liquid chlorine added)	Total coliform (Present/Absent)	Fecal coliform (Present/Absent)
1	Before treatment	TNTC	TNTC
2	1ml	ABSENT	ABSENT
3	2ml	ABSENT	ABSENT
4	3ml	ABSENT	ABSENT
5	4ml	ABSENT	ABSENT

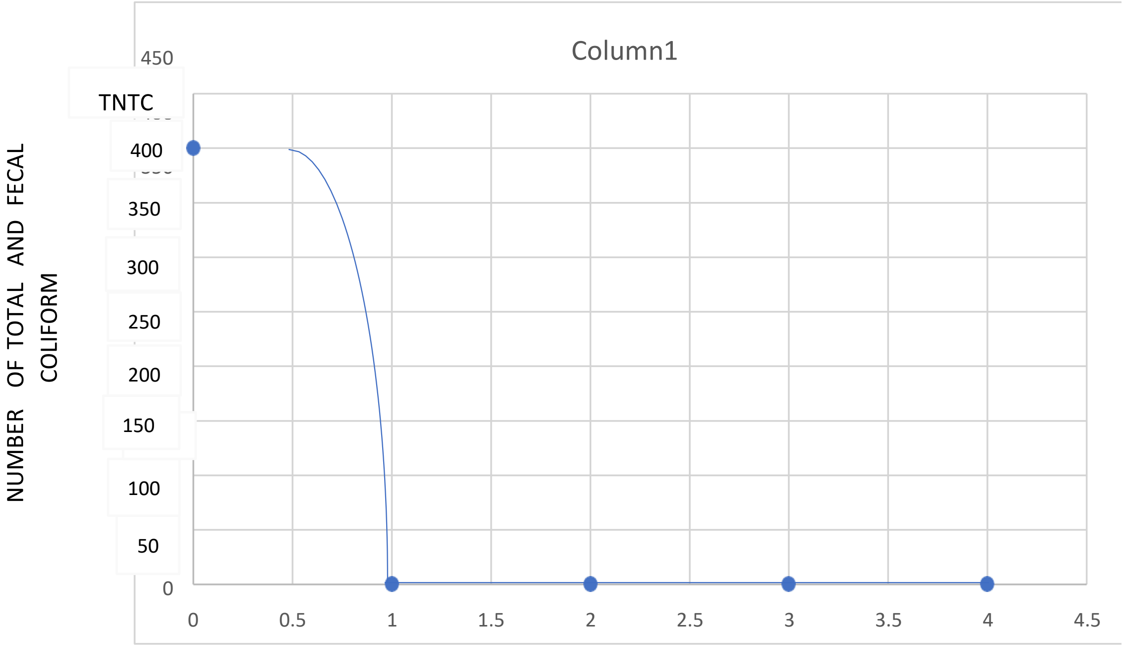


Fig 2.6. total and fecal coliform deduction using chlorine.

Comparison Of Results: The study compared the effectiveness of neem extract and liquid chlorine in disinfecting wastewater, focusing on the removal of total coliform and fecal coliform bacteria. Neem extract treatment showed a gradual reduction in bacterial contamination, with complete disinfection achieved only at a 40ml concentration. On the other hand, liquid chlorine demonstrated 100% disinfection even at the lowest tested concentration of 1ml, making it the more immediate and efficient disinfectant. While chlorine acted rapidly and effectively, neem extract required higher concentrations and longer exposure time to eliminate bacteria. However, neem extract offers a natural, ecofriendly alternative without leaving chemical residues, making it more suitable for sustainable wastewater treatment. Chlorine, though highly effective, may pose environmental concerns due to residual chemicals that could impact water quality over time. Neem-based treatment is particularly beneficial for rural and environmentally conscious applications, providing a chemical-free disinfection method. Meanwhile, chlorine remains the best choice for rapid, large-scale disinfection where immediate results are required. The study highlights that both methods have their unique advantages, and the choice between neem extract and chlorine depends on factors like environmental impact, treatment efficiency, and application needs.

IV.CONCLUSION

This project demonstrates the effectiveness of neem extract as a natural disinfectant for treating contaminated septic tank water. The study involved laboratory experiments that showed the potential of neem extract in reducing bacterial contamination in septic tank water. Increasing concentrations of neem extract were tested, and the results revealed a gradual decrease in bacterial counts, with complete disinfection achieved at a concentration of 40ml. This indicates that neem extract is a highly effective natural disinfectant that can remove total coliform and fecal coliform bacteria from contaminated septic tank water.

The proposed extra tank system with neem extract treatment offers a cost-effective, easy-to-implement, and eco-friendly solution for households to prevent groundwater contamination and ensure safe drinking water. This system can be easily integrated into existing septic tank systems, providing a sustainable and environmentally friendly approach to wastewater treatment. The use of neem extract as a natural disinfectant eliminates the need for chemical disinfectants, reducing the risk of environmental pollution and promoting a healthier ecosystem.

Implementing this model in real-world settings could have significant benefits for public health and environmental sustainability. By providing a natural and effective solution for treating contaminated septic tank water, this system can help reduce the risk of waterborne diseases and promote safe drinking water. Additionally, the use of neem extract as a natural disinfectant supports sustainable wastewater management practices, reducing the environmental impact of wastewater treatment and promoting a healthier environment for future generations.

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