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Investigating the Effects of Different Garbage Enzyme Dilutions on Domestic Wastewater Treatment

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Abstract: ***Rapid population growth has led to increased domestic wastewater generation, requiring sustainable methods like garbage enzyme (GE). This study aims to investigate the effects of different dilutions of garbage Enzyme on domestic wastewater, aiming to maximize efficiency and promote wider application in wastewater treatment plants. The study aimed to evaluate the efficacy of garbage enzyme in treating domestic wastewater using different concentrations of GE. The crucial water quality parameters like pH, TDS, TSS, TDS, P, SO4, NH3N, BOD, and COD were tested to see the efficacy of GE in reducing them. In conclusion, the study found that garbage-enzyme can effectively treat domestic wastewater using different concentrations of GE. Further research is needed to determine the optimal GE concentrations and treatments for achieving the desired results.***

Keywords: Garbage Enzyme, Domestic wastewater, Organic waste, Bio Enzyme, Fruit peel Enzyme, Water Treatment.

I. INTRODUCTION

The world population was 3 billion in 1960, which increased to 7 billion in 2011, and it is expected to reach 8.1 billion by 2025 (FAO, 2013). This rapid population growth has led to an increase in domestic wastewater generation, posing a significant challenge for wastewater treatment plants. Traditional methods of wastewater treatment involve the use of chemicals and energy-intensive processes, which are not only expensive but also have negative environmental impacts. As a result, there is a growing interest in exploring alternative and sustainable methods for wastewater treatment. One such method is the use of garbage enzymes, which are natural and cost-effective solutions derived from fruit and vegetable waste. Garbage enzymes contain a mixture of beneficial microorganisms that can break down organic matter and enhance the degradation of pollutants in wastewater. However, the effectiveness of garbage enzymes in wastewater treatment is influenced by various factors, including enzyme dilution. Therefore, this study aims to investigate the effects of different garbage enzyme dilutions say 10%, 15% and 20% on domestic wastewater. By understanding the optimal dilution ratio, we can maximise the efficiency of garbage enzymes and promote their wider application in wastewater treatment plants. This research will contribute to the development of sustainable and eco-friendly solutions.

The world generates 2.01 billion tonnes of municipal solid waste annually, with at least 33 percent of that—extremely conservatively—not managed in an environmentally safe manner. Worldwide, waste generated per person per day averages 0.74 kilograms but ranges widely, from 0.11 to 4.54 kilograms. Though they only account for 16 percent of the world's population, high-income countries generate about 34 percent, or 683 million tonnes, of the world's waste (Trends in Solid Waste Management, n.d.). Additionally, forecasts for the generation of solid waste indicated that it will increase by about 70% by 2050, necessitating a huge focus on environmentally friendly methods for waste management, treatment, and disposal (Trends in Solid Waste Management, n.d.). More than 60 percent of the increase in the world's urban population over the next three decades will occur in Asia, particularly in China and India. (Urbanisation Takes on New Dimensions in Asia's Population Giants, 2001). India is one of the newly industrialised nations in Asia, making up 17.3% of the world's population. Urban areas in India have an average organic waste share of approximately 51%. (Speier et al., 2018) , a future significant issue with effective solid waste management is improper segregation of the organic fractions of MSW, which would result in environmental pollution and prevent the effective use of the organic wastes' potential for the production of bioenergy. The organic fractions primarily consist of household waste, waste from the vegetable, fruit, and flower markets, etc. The major sources of organic waste generation hotspots in Indian urban cities are the organic waste fractions, such as waste from wholesale markets such as vegetable, fruit, and flower markets. Therefore, there is a critical need for sustainable waste management in Indian urban centres as a result of these large-scale organic wastes from centralised wholesale markets.

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II. MATERIALS AND METHODS

A. Garbage Enzyme Preparation

To make garbage enzyme, molasses, mixed fruit peel waste, and water were combined in a ratio of 1:3:10 (Oon, 2008), in expandable, airtight plastic containers. To prevent rupturing, the container's pressure was released every day. Orange peels were occasionally pushed downward. The container was positioned in an area that was cool, dry, and well-ventilated. To create the garbage enzyme, it was allowed to ferment for three months. A brownish liquid was produced by the fermentation and separated from the solids. The solution was filtered to obtain the enzyme solution. The enzyme solution that was obtained was pale brown. Then it was put into a plastic bottle, as per Arun & Sivashanmugam (2015). For the study, fruit waste was collected from juice vendors and fruit markets. About 2 kg of Molasses available in the market were brought, and 6 kg of fruit waste was mixed, then about 20L of water was added and fermented in 25L air-tight plastic container to obtain around 20L of garbage enzyme. It was opened occasionally to release the gases and to check for moulds. This is repeated almost 15 times to complete the studies. Thus, obtained garbage enzyme is used for the study.

Various garbage enzyme concentrations say 10%, 15% and 20% meaning 10L of GE mixed in 100L of Domestic wastewater making it 10% GE, so were GE and 20% were used to assess garbage enzyme efficiency in treating domestic wastewater. Further, all the sampling and parameter analysis are met with APHA standard methods and procedures. The readings were recorded on the 10th, 20th, 30th, 60th, and 90th days of incubation.

III. RESULTS AND DISCUSSION

1) *pH Concentration:* When concentrations of 10%, 15%, and 20% GE were used in the study, the variations in pH of the domestic waste with 15% GE produced superior results, bringing the pH of the domestic waste from 8.0 to 7.1 on the 20th day of incubation. In contrast, the pH of the domestic waste began to fall after the 30th, 60th, and 90th days of incubation. When 10% of the enzyme was used, a lowering trend in the pH from 8 to 5.7 over the 90th day was seen. After 20 days of incubation, a pH of 7.2 was noted. The pH readings were showing a decreasing tendency even in 20% GE studies. In this Experiment, 10 days of incubation showed a neutral pH, and then the pH showed a falling tendency to 5.1, which is slightly acidic.

TABLE 1: VARIATION OF PH WITH DIFFERENT PERCENTAGES OF GE IN DOMESTIC WASTE

Variation of pH with different percentages of GE in domestic waste						
percentage of GE	Effect of pH on different days					
	Raw	10thDay	20thDays	30thDays	60thDays	90thDays
10%GE	8	7.5	7.2	6.9	6.1	5.7
15%GE	8	7.2	7.1	6.3	6.3	5.3
20%GE	8	7	6.9	6.5	6.9	5.1

*pH has No units.

Nazim (2013), in a similar study on synthetic grey water, recorded a pH of 6.5 that increased to 6.9 and 6.8 with 5% and 10% of GE treated for 5 days. Rani et al. (2020) recorded a reduction in pH from 8.2 to 6.14, 7.9 to 5.34, and 9.2 to 5.26 in 10%, 15%, and 20% of GE treated, respectively, for 28 days on Okhla landfill leachate. Arun and Sivashanmugam (2018), in a study on optimised multi-hydrolytic garbage enzyme complex (OGEC) produced from pre-consumer organic waste used to hydrolyze dairy waste-activated sludge, reported the best results of hydrolysis at pH 7 and also reported that the pH of Dairy activated sludge from 6.5 was increased to 7.5 in 45 hours.

2) *TDS Concentration:* The TDS value of raw domestic wastewater was 1487 mg/L; subsequently, a decline was observed until the 60th day (741 mg/L), but on the 90th day, it increased to 805 mg/L with the dilution of 10% GE. 15% GE addition to domestic wastewater the TDS value decreased and reached the lowest value, which is 420 mg/L on the 60th day and then increased again on the 90th day of incubation. The same trend was observed with a 20% enzyme treatment. Till 60 days of incubation, a decrease in TDS was observed (801 mg/L), whereas, at 90 days, it again increased (823mg/L).

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TABLE 2: VARIATION OF TDS WITH DIFFERENT PERCENTAGES OF GE IN DOMESTIC WASTE

Variation of TDS with different percentages of GE on domestic waste (mg/L)						
percentage of GE	Effect of TDS on different days					
	Raw	10thDay	20thDays	30thDays	60thDays	90thDays
10%GE	1487	830	793	750	741	805
15%GE	1487	600	531	515	420	650
20%GE	1487	1200	1004	984	801	823

In a similar study, Nazim (2013) recorded a reduction of TDS in Synthetic grey water from 563 to 256, 232, 410, and 532 with 5%, 10%, 20%, and 50% of GE, respectively, on incubation for 28 days. The best results were observed at 10% on the 27th day. Rani et al. (2020), in their study on leachate treatment for 28 days on three samples from Bhalswa Landfill, Okhla Landfill, and Ghazipur Landfill with 5%, 10%, 15%, and 20% GE, recorded that the TDS reduced from 9235 to 4513 with 5% GE in Bhalswa leachate, 5629 to 1998 with 20% GE, and 10,000 to 4573 with 15% GE.

TSS Concentration: From Table 3, it was observed that the TSS increased beyond the raw values in all dilutions and started to decline after 10 days. 10% of the GE treatment after 10 days of incubation showed a maximum value of 41 mg/L, whereas it reached 10 mg/L after 90 days of incubation. The suspended solids were increased to a maximum of 48 mg/L, but if they decreased to 6 mg/L, they remained at 6 mg/L even after 90 days of incubation. When 20% GE was used similar trend was noticed.

TABLE 3: VARIATION OF TSS WITH DIFFERENT PERCENTAGES OF GE IN DOMESTIC WASTE

Variation of TSS with different percentages of GE on domestic waste (mg/L)						
percentage of GE	Effect of TSS on different days					
	RAW	10thDay	20thDays	30thDays	60thDays	90thDays
10%GE	16	41	38	23	11	10
15%GE	16	48	45	34	6	6
20%GE	16	53	40	29	14	18

Kumar et al. (2019) recorded a reduction in TSS from 121mg/L Pre-GE treatment to 47mg/L post-GE treatment on the River Yamuna in Delhi. Parmar et al. (2001) studied the enzymatic reduction of Suspended Solids and reported a 50% reduction in TSS due to protease, lipase, cellulase, and hemicellulose activity for 5 days.

3) *Total Solids:* Total solids were calculated by summing up the values of TDS and TSS. From Table 4, it was evident that there was a decrease in the values from 1503mg/L to 752mg/L by 60 days of incubation. But this trend was not followed after 90 days of incubation, increasing the value (815mg/L). In 15% of treatments, the observed decrease was appreciable until 60 days (426 mg/L), whereas this value increased drastically (656 mg/L) by 90 days of incubation. In 20% of treatments, the TS recorded value was at its maximum (1253mg/L) in 10 days of incubation, decreased to 815mg/L by 60 days, and again increased to 841mg/L by 90 days of incubation.

Kumar et al. (2019) recorded a reduction in TS from 884 mg/L Pre-GE treatment to 745 mg/L post-GE treatment on the River Yamuna in Delhi after 45 days of treatment.

TABLE 4: VARIATION OF TS WITH DIFFERENT PERCENTAGES OF GE ON DOMESTIC WASTE

Variation of TS with different percentages of GE on domestic waste						
percentage of GE	Effect of TS on different days					
	1stDay	10thDay	20thDays	30thDays	60thDays	90thDays
10%GE	1503	871	831	773	752	815
15%GE	1503	648	576	549	426	656
20%GE	1503	1253	1044	1013	815	841

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4) *Biological Oxygen Demand:* From Table 5, it was observed that among the different concentrations of enzyme, 15% treatment reduced the BOD drastically (54 mg/L) for 20 days of incubation. There was an increase in reading from 54 to 107 mg/L in 90 days of incubation. In 20% of enzyme studies, the maximum decrease of BOD (68mg/L) took 20 days of the incubation period. Again, an increase (121 mg/L) was observed until 90 days of incubation.

TABLE 5: VARIATION OF BOD WITH DIFFERENT PERCENTAGES OF GE IN DOMESTIC WASTE

Variation of BOD with different percentages of GE on domestic waste						
percentage of GE	Effect of BOD on different days (mg/L)					
	1stDay	10thDay	20thDays	30thDays	60thDays	90thDays
10%GE	210	180	72	98	120	154
15%GE	210	90	54	84	96	107
20%GE	210	107	68	100	112	121

In a similar study, Nazim (2013) recorded a reduction in BOD values after 27 days of Synthetic grey water treatment, with the initial value of 192mg/L reduced to 74, 68, 91, and 96 mg/L with 5%, 10%, 20%, and 50% GE, respectively, where 68mg/L was achieved at 10% GE. Kumar et al. (2019) observed that BOD3 increased from 0.4mg/L to 1.0mg/L post-treatment with GE for 45 days on the Yamuna in Delhi. Bhavani et al. (2019), in a study on a freshwater pond, found BOD reduced from 39.5 mg/L to 16 mg/L after treating the pond with 1:10000 GE with water for 90 days. Rani et al. (2020), in their study on leachate treatment for 28 days on three samples from Bhalswa Landfill, Okhla Landfill, and Ghazipur Landfill with 5%, 10%, 15%, and 20% GE, recorded that the BOD reduced from 2948 mg/L to 561 mg/L with 5% GE in Bhalswa leachate, 3394 to 301 mg/L with 15% GE in Okhla Landfill, and 7455 mg/L to 518mg/L with 5% GE at Ghazipur Landfill.

5) *Chemical Oxygen Demand:* In the general effluent treatment process, BOD and COD play a very important role in determining treatment efficiency. From Table 6, it was evident that the 15% GE treatment proved good after 20 days of incubation; again, a similar trend of increase was observed until 90 days of incubation. The initial reading was 337mg/L; it reaches 110mg/L in 20 days, so incubation in 10% GE treatment A similar trend was observed in 15% and 20% of incubations, respectively. In both cases, the decrease was appreciable after 20 days of incubation, which is 80 and 111 mg/L, respectively. Increasing afterwards was also similar in both treatments, that is, 15% and 20% treatments until 90 days of incubation.

In a similar study, Nazim (2013) recorded a reduction in COD values after 27 days of Synthetic grey water treatment, with the initial value of 290mg/L reduced to 72,62,128,240mg/L with 5%, 10%, 20%, and 50% GE, respectively, where 62mg/L was achieved at 10% GE. Kumar et al. (2019) observed a COD of 256 mg/L reduced to 176 mg/L post-treatment with 45 days of incubation on the Yamuna in Delhi. Bhavani et al. (2019), in a study on a freshwater pond, found COD reduced from 121 mg/L to 40 mg/L after treating the pond with 1:10000 GE with water for 90 days.

TABLE 6: VARIATION OF COD WITH DIFFERENT PERCENTAGES OF GE ON DOMESTIC WASTE

Variation of COD with different percentages of GE on domestic waste						
percentage of GE	Effect of COD on different days					
	1stDay	10thDay	20thDays	30thDays	60thDays	90thDays
10%GE	337	264	110	153	178	215
15%GE	337	271	80	98	122	157
20%GE	337	183	111	152	169	200

Rani et al. (2020), in their study on leachate treatment for 28 days on three samples from Bhalswa Landfill, Okhla Landfill, and Ghazipur Landfill with 5 different concentrations of GE (1%, 5%, 10%, 15%, and 20%), observed varying levels of COD reduction. The highest reduction was achieved at 20% GE, with COD levels decreasing from 350 mg/L to 180 mg/L in the Bhalswa Landfill sample. Similarly, in the Okhla Landfill sample, COD levels dropped from 400 mg/L to 220 mg/L with the same concentration of GE. The Ghazipur Landfill sample showed a decrease in COD from 450 mg/L to 250 mg/L when treated with 20% GE.

At lower concentrations of GE, the reduction in COD was less significant. For instance, at 1% GE, the Bhalswa Landfill sample only saw a decrease in COD from 350 mg/L to 320 mg/L. Overall, these studies demonstrate the effectiveness of using GE for COD reduction in various water bodies and leachate samples, with higher concentrations of GE yielding better results: 5%, 10%, 15%, and 20% GE reduced the COD from 5216 mg/L to 1005 mg/L with 5% GE in Bhalswa leachate, 5977 mg/L to 394 mg/L with 20% GE in Okhla Landfill, and 7692mg/L to 748mg/L with 5% GE at Ghazipur Landfill.

6) *Concentration of phosphates:*

TABLE 7: VARIATION OF P WITH DIFFERENT PERCENTAGES OF GE ON DOMESTIC WASTE

Variation of Phosphates with different percentages of GE in domestic waste (mg/L)						
percentage of GE	Effect of P on different days					
	1stDay	10thDay	20thDays	30thDays	60thDays	90thDays
10%GE	1.3	0	0	0	0	0
15%GE	1.3	0	0	0	0	0
20%GE	1.3	0	0	0	0	0

Phosphates are essential to animals and plants, but an excess of them in surface water can cause the dominance of aquatic plants and algae. Very interesting observations were recorded for this parameter, phosphates. The initial reading was 1.3 mg/L; the rest all showed 0 values in three percentages and on all days of incubation.

In a similar study of greywater treatment, Nazim (2013) recorded a drastic reduction in Phosphates with GE treatment. The initial values of 110 mg/L were completely removed with all dilutions of GE, i.e., 5%, 10%, 20%, and 50% of GE in 5 days.

7) *Concentration of Sulphates:* The presence of sulphates in effluent treatment is an indicator of water quality; the more sulphates, the less good the water is. 142 mg/L sulphates were found in the raw domestic wastewater; however, by the 10th day in 10%, 15%, and 20% GE, the sulphates had fallen below 45, and by 30 days, sulphates were completely removed from the wastewater.

Rani et al. (2020), in their study on leachate treatment for 28 days on three samples from Bhalswa Landfill, Okhla Landfill, and Ghazipur Landfill with 5%, 10%, 15%, and 20% GE, recorded complete removal of sulphates from 0.5 mg/L with 5%, 10%, 15%, and 20% GE in three sites of their study.

TABLE 8: VARIATION OF SULPHATES WITH DIFFERENT PERCENTAGES OF GE ON DOMESTIC WASTE

Variation of sulphates with different percentages of GE on domestic waste (mg/L)						
percentage of GE	Effect of sulphates on different days					
	1stDay	10thDay	20thDays	30thDays	60thDays	90thDays
10%GE	142	34	10	0	0	0
15%GE	142	45	1.2	0	0	0
20%GE	142	31	11	0	0	0

8) *Concentration of NH_3-N:* Ammonical nitrogen is often used as an indicator of the organic pollution level in wastewater. It is primarily derived from the breakdown of nitrogenous organic compounds such as proteins and amino acids found in human and animal waste. Very interesting observations were recorded in the raw domestic wastewater; the initial reading was 30 mg/L. However, on incubation with 10%, 15%, and 20% GE By the 10th day, more than a 50% reduction in values was observed, and by the 20th day, in all the dilutions, the values recorded only showed values below detectable limits.

TABLE 9: VARIATION OF N-NH_3 WITH DIFFERENT PERCENTAGES OF GE IN DOMESTIC WASTE

Variation of ammonical N with different percentages of GE on domestic waste (mg/L)						
percentage of GE	Effect of ammonical N on different days					
	1stDay	10thDay	20thDays	30thDays	60thDays	90thDays
10%GE	30	11	0	0	0	0
15%GE	30	9.6	0	0	0	0
20%GE	30	8.4	0	0	0	0

In a similar study of greywater treatment, Nazim (2013) recorded a drastic reduction in ammonia with GE treatment. The recorded initial values of 9.6 mg/L were completely removed with all dilutions of GE, i.e., 5%, 10%, 20%, and 50% of GE in 5 days of treatment.

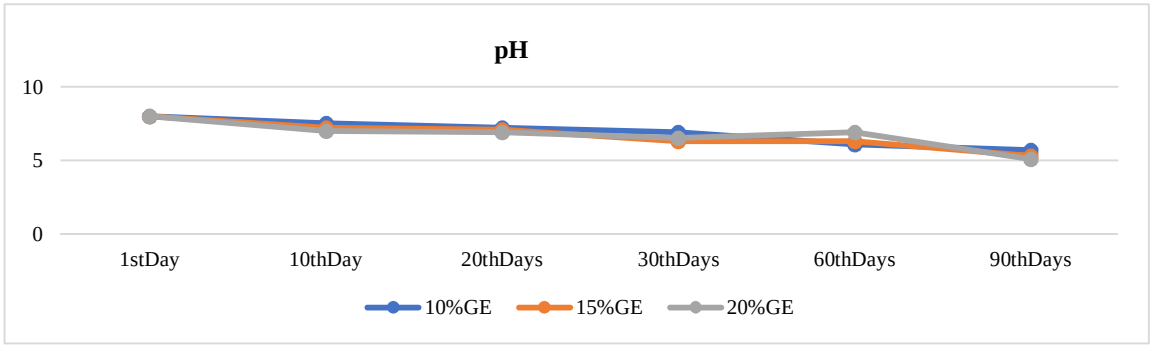


FIG. 1- GRAPH SHOWING VARIATIONS OF PH WITH DIFFERENT GE DILUTIONS

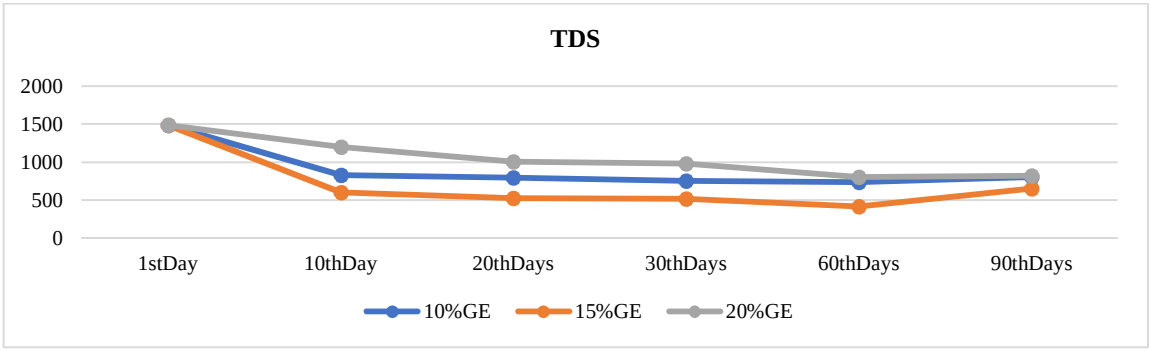


FIG. 2, GRAPH SHOWING VARIATIONS OF TDS WITH DIFFERENT GE DILUTIONS

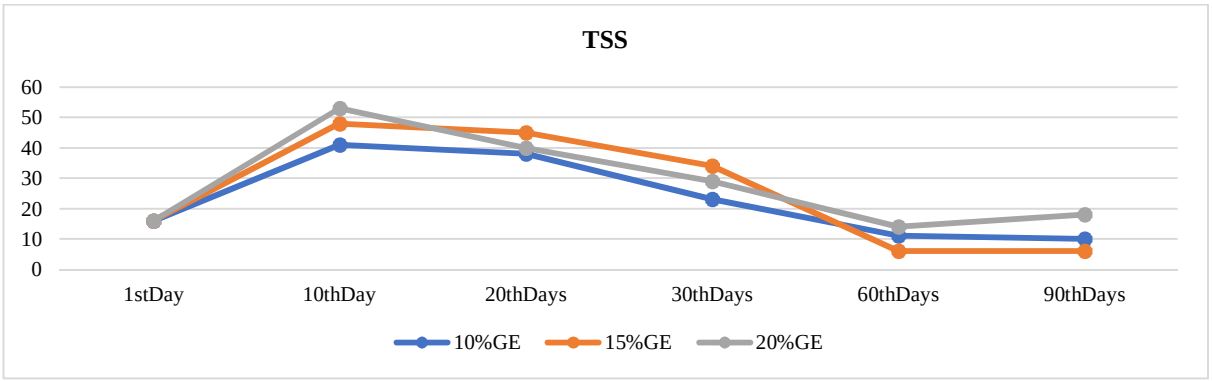


FIG. 3, GRAPH SHOWING VARIATIONS OF TSS WITH DIFFERENT GE DILUTIONS

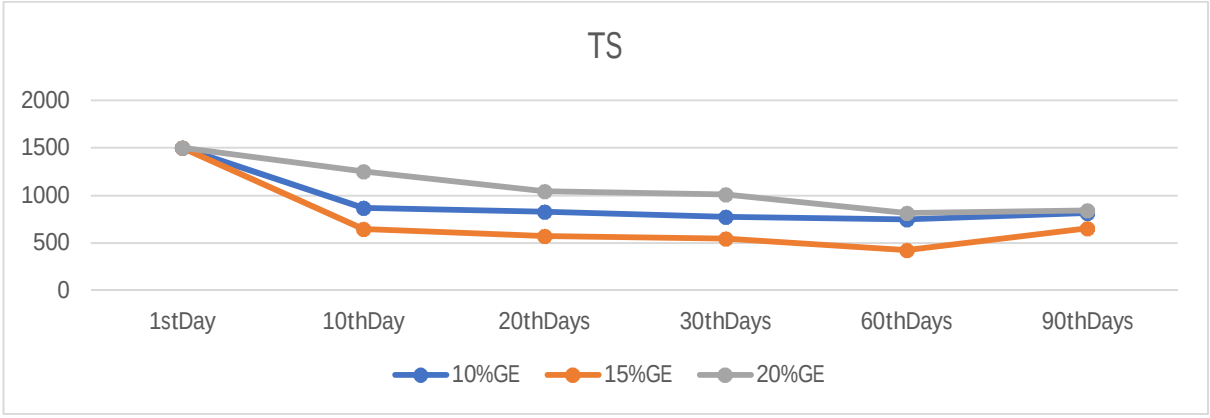


FIG. 4, GRAPH SHOWING VARIATIONS OF TSS WITH DIFFERENT GE DILUTIONS

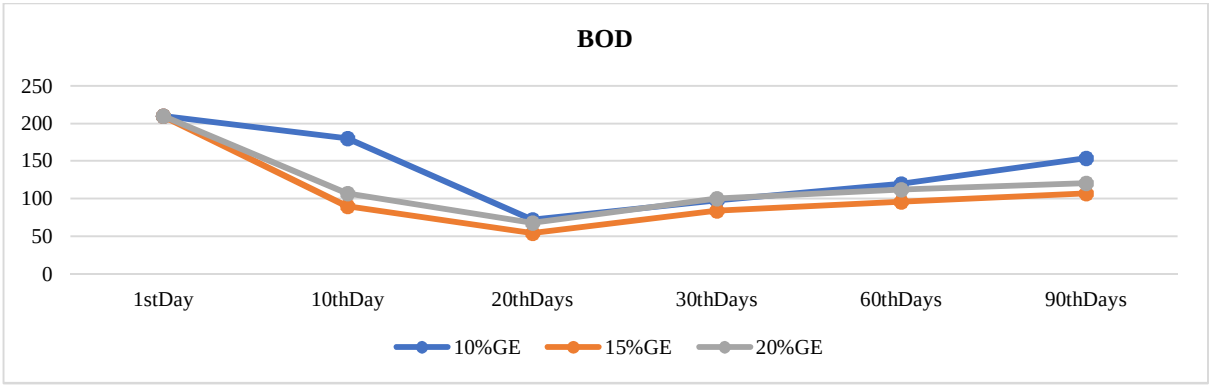


FIG. 5, GRAPH SHOWING VARIATIONS OF BOD WITH DIFFERENT GE DILUTIONS

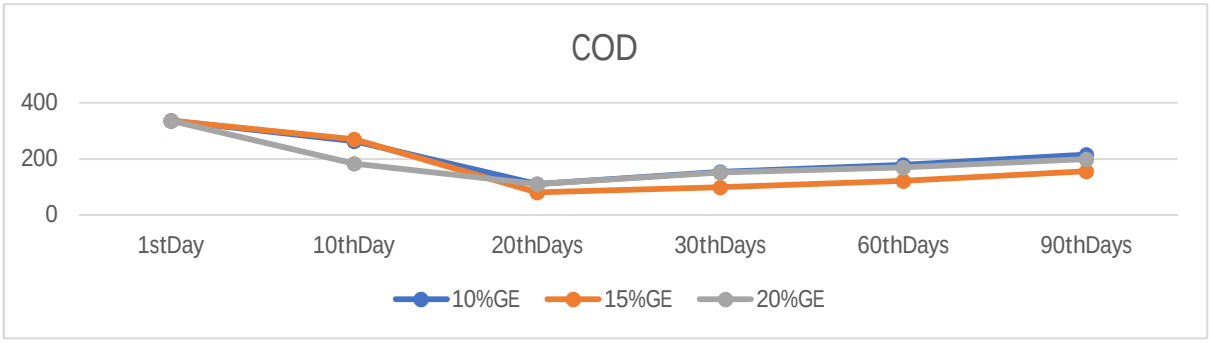


FIG. 6, GRAPH SHOWING VARIATIONS OF COD WITH DIFFERENT GE DILUTIONS

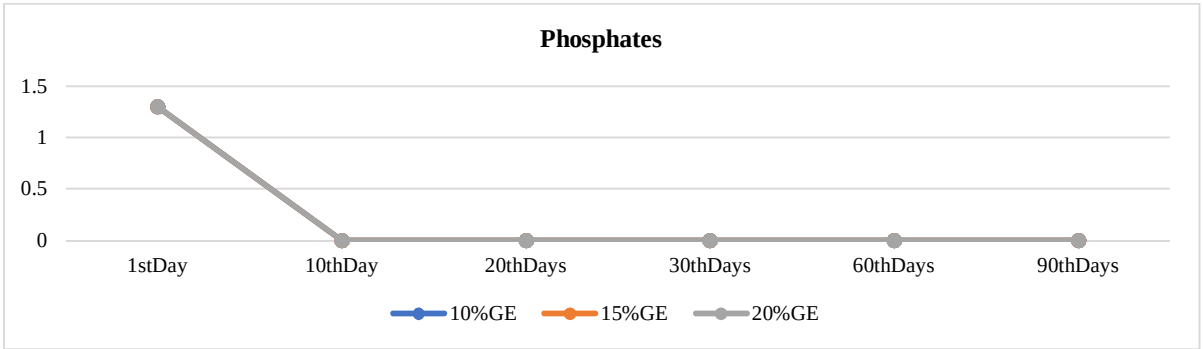


FIG. 7, GRAPH SHOWING VARIATIONS OF P WITH DIFFERENT GE DILUTIONS

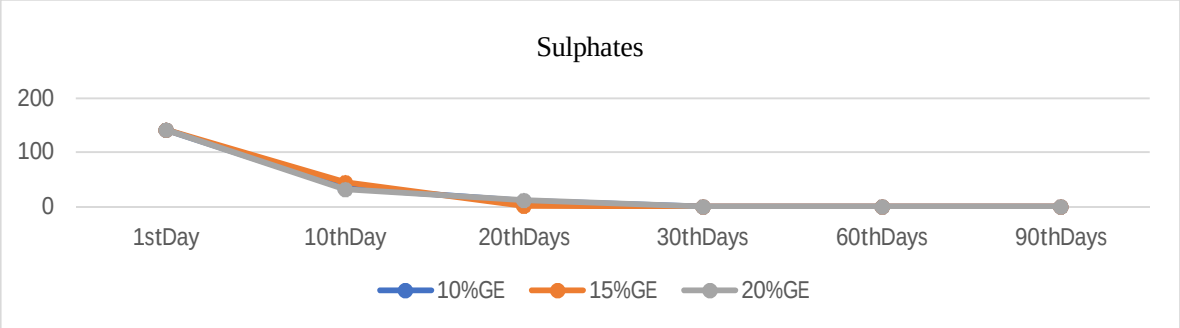


FIG. 8, GRAPH SHOWING VARIATIONS OF SULPHATES WITH DIFFERENT GE DILUTIONS

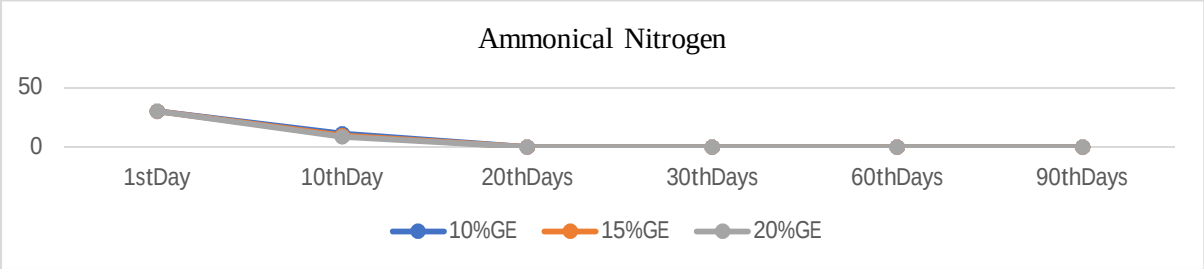


FIG. 9, GRAPH SHOWING VARIATIONS OF AMMONICAL NITROGEN WITH DIFFERENT GE DILUTIONS

IV. CONCLUSIONS

Garbage enzymes are found to be a cost-effective method to treat and dispose of domestic wastewater, which is also solving the problem of organic solid waste management. However, the Garbage Enzyme dilutions of 10%, 15%, and 20% were used in this study to treat domestic wastewater for 90 days, and the best results in most aspects were found at a 15% dilution on the 20th day of incubation. Hence, the 15% dilution of GE is more efficient than the 10% and 20% dilutions of GE. The limitation is in terms of time; a further fusion of physical and chemical methods could be tried and analysed to reduce the contact time. Still, the GE application is a very cost-effective method to dispose of Domestic wastewater.

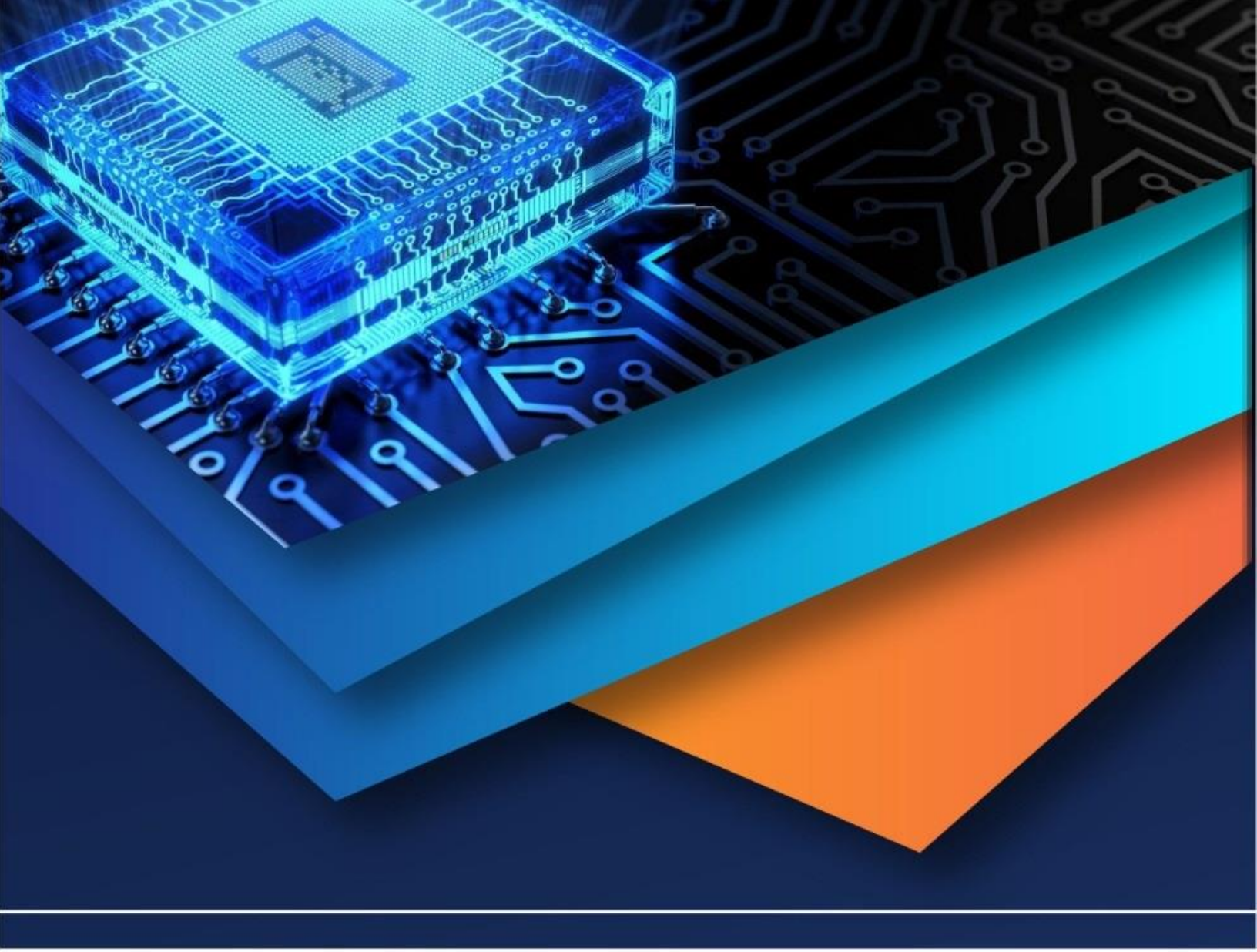
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