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A Study of the Garbage Enzyme's Effects in Domestic Wastewater

Fu E. Tang, and Chung W. Tong

***Abstract*—**"Garbage enzyme", a fermentation product of kitchen waste, water and brown sugar, is claimed in the media as a multipurpose solution for household and agricultural uses. This study assesses the effects of dilutions (5% to 75%) of garbage enzyme in reducing pollutants in domestic wastewater. The pH of the garbage enzyme was found to be 3.5, BOD concentration about 150 mg/L. Test results showed that the garbage enzyme raised the wastewater's BOD in proportion to its dilution due to its high organic content. For mixtures with more than 10% garbage enzyme, its pH remained acidic after the 5-day digestion period. However, it seems that ammonia nitrogen and phosphorus could be removed by the addition of the garbage enzyme. The most economic solution for removal of ammonia nitrogen and phosphorus was found to be 9%. Further tests are required to understand the removal mechanisms of the ammonia nitrogen and phosphorus.

***Keywords*—**Wastewater treatment, garbage enzyme, wastewater additives, ammonia nitrogen, phosphorus

I. Introduction

DUE to the increase of the worldwide population, the problem of sewage disposal and industrial waste management has become increasingly critical. Nearly 70-80% of rivers and streams carry polluted water [1]. Catastrophic impacts on human health and on the environment could result if pollution of receiving waters is allowed to continue. Therefore, to preserve water quality for future generations, an effective means of solving this problem must be developed [1]. Wastewater treatment technology has been improving, and currently it is possible to treat wastewater to a highly usable level efficiently and cheaply. Although treatment of wastewater and its legislation is well instituted in urban and rural areas in developed countries; proper sanitation, with efficient treatment, has not been practiced in many other places, especially in suburban areas in developing countries like Malaysia [2].

For domestic wastewater treatment, the removal of biological organic pollutants and nutrients is the main priority. Municipal wastewater typically consists of domestic wastewater (50 - 90%) originating from residential sources, commercial wastewater (5 - 30%) and industrial wastewater (5 - 20%) [2]. Although micro pollutants like endocrine disruptors, pharmaceuticals and acetaminophen are present in very low concentrations in domestic wastewater [3], they could ultimately react with disinfectants from water treatment and form hazardous products. Thus, wastewater should be treated properly before being discharged to receiving water bodies.

F. E. Tang is with Curtin University Sarawak Campus, CDT 250, 98009 Miri, Sarawak, Malaysia (phone: +60 85 443939; fax: +60 85 443837; e-mail: tang.fu.ee@curtin.edu.my).

C. W. Tong was an undergraduate with Curtin University Sarawak Campus. He is now in industry.

In wastewater treatment the goal is to achieve maximum efficiency with constant improvements in using the lowest costs, time and area. Additives may be added into wastewater treatment systems, so that specific pollutants can be degraded to a higher degree within a shorter time. A potential application is to add suitable amounts of additives into the secondary sedimentation tank (the biological treatment component) influent to remove pollutants [4]. In an activated sludge system, poor settling may occur due to certain unfavorable operational parameters, such as temperature, wastewater composition, hydraulic and organic loading rate, and dissolved oxygen levels in the aerobic zones of the aeration tank. All of these parameters affect sludge settling properties and affect the performance of solid – liquid separation in the final clarifier.

Additives in wastewater treatment are available as biological and chemical additives. Chemical additives may be harmful to the environment and are generally discouraged or banned because of strong acids, bases or toxic contents, and possibly result in adverse effects on system components, the soil structure, or ground water quality. Biological additives have significant beneficial impacts and do not directly harm traditional onsite systems. Example of types of additives used as flocculants are organic polymers, aluminum salts, lignite coke, loam – sand mixture, coal, bentonite, limestone, chemical polymer, and polyelectrolytes [4]. An example of an additive to wastewater treatment is the addition of Microcat - XNC for nitrification of ammonia to nitrates in low temperatures [5]. This additive functions to lower temperature to increase the bacterial activity.

Enzymes used in wastewater belong to the category of biological additives. Enzyme additives like laccase has been widely used and explored in wastewater treatment systems to treat specific pollutants ([1], [6]). Enzymes had also been used in pre-treatment of wastewater, in particular in wastewater rich in lipids and fats [7]. Pancreatic lipase was used for hydrolysis and to reduce the size of fat particles in slaughterhouse wastewater [8], and for hydrolysis of wastewater from dairy industries [9]. A review of oxidative enzymes in wastewater, originating from bacteria, fungi and plants, and phenoloxidases, including laccase, is presented by Duràn and Esposito [10].

In wastewater treatment, due to a lack of complex digestive systems, bacteria need to pre-digest the potential food source such as organic and inorganic materials in wastewater outside their cell boundaries first. To accomplish this pre-digestion, bacteria excrete enzymes through their enveloping membrane with its supportive cell wall into the surrounding environment. These "extra – cellular enzymes" are reasonably stable, highly resistant to chemicals, and are able to function over a relatively broad temperature range, in order to survive in the environment outside the protection of the cell's wall and membrane [11].

Enzymes produced by bacteria are used to catalyze the digestion of certain large organic molecules so that they can absorb the very small nutrient compounds of pre-digested foods. Each type of enzyme may only be able to degrade specific pollutants, catalyzing select chemical reactions and only with select substances. Therefore, certain enzymes can treat specific types of organic pollutants only [1]. Substrates such as phenols, chlorophenols, methylated phenols, biphenols, anilines, benzidines, and other heterocyclic aromatic compounds that are under dilute conditions and are less sensitive to operational upsets may also be treated by enzymes. Among these enzymes, oxidoreductases, laccases, and peroxidases have great potential in targeting a wide spectrum of organic pollutants. These enzymes convert a range of substrates into less toxic insoluble compounds, which can be easily removed from waste [1]. A list of enzymes and their potential applications for waste treatment is presented in Table I.

TABLE I
LIST OF ENZYMES AND THEIR POTENTIAL APPLICATIONS FOR THE TREATMENT OF ORGANIC WASTE [1]

Enzyme	Source	Applications	References
Alkylsulfatase	Psetudomonas C12B	Surfactant degradation	Thomas and White, 1991
Azoreductase	Psetudomonas sp	Decolorization of dyes	Husain, 2006
Chitinase	Serratia marcescens	Bioconversions of selfish waste	Cosio et al, 1982
Chloro – peroxidase	Caldariomyces fumago	Oxidation of phenolic compounds	Altken et al, 1994
Cyanidase	Alcaligeners denitrificans	Cyanide decomposition	Basheer et al, 1992
Haemoglobin	Blood	Removal of phenols, and aromatic aminers	Chapsal et al, 1986
Laccase	Several fungi, e.g, Trametes versicolor, Fomas annosus	Removal of phenols, decolorization of kraft bleaching effluents, binding of phenols and aromatic amines with humus	Duran and esposito, 2000; Duran et al, 2002; Christian et al, 2005; Husain, 2006
Lignin peroxidase	Pbanerocbaete cbrysosporium	Removal of phenols and aromatic compounds, decolorization of kraft bleaching effluents	Christian et al, 2005; Husain, 2006
Lipase	Various sources	Improved sludge dewatering	Thomas et al, 1993; Jeganathan et al, 2006
Lysozyme	Bacterial	Improved sludge dewatering	
Manganese peroxidase	Pbanerocbaete cbrysosporium	Oxidation of phenols and aromatic dyes	Duran and Esposito, 2000; Christian et al, 2005; Husain, 2006
Microperoxidase - 11	Horse heart	Decolorization of dyes	Hussain, 2006
Peroxidase	Horsetadish roots, tomato, white radish, turnip, bitter gourd	Oxidation of phenols, aromatic amines and dyes, decolorization of kraft bleaching effluents	Akhtar et al, 2005a, 2005b; Akhtar and Husain 2006, husain 2006; Kulshrestha and Husain, 2007; Matto and Husain 2007
Phosphatase	Citrobacter, sp	removal of heavy metals	Thomas et al, 1993
Proteases	Bacterial, e.g, Bactilus subtilis, Pseudomonas marinogluttinosa	Solubilization of fish and meat remains	Karam and Nicell, 1977
Tyrosinase	Mushroom	Removal of phenols, aromatic amines	Duran and Esposito, 2000; Duran et al, 2002
Polyphenol oxidases	Solanum melongena, Solanum tuberosum	Reactive and other dyes, dye effluents	Khan et al, 2007; Khan and Husain, 2007
Organophosphorus hydrolase	Bacterial and recombinant	Organophosphorus compounds	Shimazu et al, 2001; Mansee et al, 2005; Lei et al, 2005
Toluene oxygenases	Bacterial and recombinant	Hydrocarbons	Yeager et al, 2004; Johnson et al, 2006
Parathione hydrolase	Pseudomonas, Flavobacterium, Streptomyces sp	Hydrolysis of organophosphate pesticides	Caldwell and Raushel, 1991

In most cases the mechanisms of enzyme activity are complex and not fully understood. A simple theory that can fit many enzyme mechanisms is called the “lock and key model”, which suggests that the shapes of the reacting molecule (the substrate) and the enzyme is postulated as a model such that they fit together much as a key fits a specific lock [12]. Enzymes will split off from the organic molecules to catalyze another reaction after the biochemical reactions are complete and products are formed. By increasing the quantity of the substrate or raising temperature, the rate of reaction can be increased, unless the enzyme concentration is limited [11].

The garbage enzyme has been touted in the Malaysian media recently as a multipurpose solution for a range of uses, including fertilizer and insect repellent in the garden, household cleaning and even as personal shampoo and detergent [13]. Some organizations have produced their own garbage enzyme and poured it into polluted rivers, claiming that the garbage enzyme removes the pollutants in the river and can improve its water quality [13]. Some of the touted uses of the garbage enzyme for agriculture and as a domestic cleaning agent is presented in Table II.

TABLE II
USAGE OF THE GARBAGE ENZYME IN AGRICULTURE AND DOMESTIC CLEANING [14]

Agriculture	Domestic cleaning
To reduce the usage of chemical fertilizers	As a general household cleaning liquid
To keep the farm free from insects and infections	To remove foul odours, molds and grime in the kitchen and toilet
As a soil fertilizer for vegetable growing	As an anti- bacterial and anti – viral agent
As a natural pesticide and herbicide	To drive away insects
To convert sandy land to fertile farm	To clean carpets and remove ticks

land	
Keep the air cool and clean in the farm atmosphere	For laundry washing and ironing
Clean the dirty and impure water in the farm	For mopping floors
Added to the animal feed to aid in their food digestion	For cleaning cars

The garbage enzyme is a fermentation product based on vegetable-based kitchen waste such as fruit peels and vegetable trimmings, water and brown sugar. The fermentation process requires three months. Recipes for production of the garbage enzyme at home have been published in the media ([15], [16]). Sugar is used frequently as a substrate in fermentation processes; in the production of lactic acid, polyhydroxybutyrate, ethanol, pullulan, xanthan gum, and molasses has been widely used as a substrate in fermentation processes [17]. The proponents of the garbage enzyme describe it as a complex organic substance of protein chains, mineral salts and juvenile hormones [18], and also claim that it functions to decompose, transform as well as catalyze reactions [18]. It is also claimed that the garbage enzyme functions differently in different concentrations [19]. However, no literature on its constituents or molecular structure, as well as scientific studies on its components, effects of usage and mechanisms of its reaction have been found at the time of the study.

This paper presents a study of the effects of the garbage enzyme on domestic wastewater, as to determine if it aids or hinders the removal of pollutants in domestic wastewater. As the proponents of the garbage enzyme claims that it aids decomposition [18], it is theorized that the garbage enzyme may function similarly to enzymes in achieving a higher degree of degradation within a shorter time for domestic wastewater. In this preliminary study, due to the complexity of the laboratory determination, it is not possible to characterize the garbage enzyme and determine its constituents. If it is found to produce any effects on wastewater here, the mechanism of its reaction will be determined in future studies. However, the current study aims to explore the effects of dilutions of the garbage enzyme in domestic wastewater, which is produced based on the methodology and recipe published ([15]. [16]). A degradation or digestion period of 5 days (as per BOD_5) is allowed to determine if the garbage enzyme affects the wastewater in any form. If the garbage enzyme is found to be useful in the degradation of wastewater, it may be utilized as a low-cost alternative to improve wastewater treatment processes.

II. Methodology

A large batch of garbage enzyme had been produced for this study, from the methodology and recipes published in the media, using clean water without chlorine content. To produce about 10L of garbage enzyme, 3kg of vegetable and fruit biomass was fermented together with 1kg brown sugar and 10L water for three months. The fermentation yielded a brownish liquid, which was separated from the solids. To study the effects of the garbage enzyme on wastewater, varying mixtures of garbage enzyme with wastewater is allowed to digest for a period of 5 days, to allow the enzyme to affect the wastewater. Water quality tests are carried out during and after the digestion period to determine its effects. The test is divided into three phases as shown in Table 3. To further study the effects of degradation of the wastewater constituents, monitoring of the water quality parameters is carried out daily, over the 5-day digestion period (phases 2 and 3, Table 3). Mixtures of the wastewater sample are tested for six water quality parameters, namely pH, ammonia nitrogen (NH_3-N), phosphorus (P), chlorine, nitrate (NO_3-N). All of these testing parameters were carried out with the Hach self – contained Surface Water Test Kit. The 5-day Biochemical Oxygen Demand (BOD_5) test is conducted according to Standard Method for the Examination of Water and Wastewater 5210: Biochemical Oxygen Demand, published by American Public Health Association (APHA), American Water Works Association, Water Environment Federation (1999). Due to space constraints, the standard methodologies for these tests are not presented here.

TABLE III
LABORATORY TESTS FOR DILUTIONS OF GARBAGE ENZYME IN DOMESTIC WASTEWATER

Laboratory tests	Dilution of garbage enzyme to wastewater (by volume)	Parameters monitored (as described in section 3)	Testing period
Phase 1	5%, 10%, 25%, 50%, 75%	All	Before and after digestion
Phase 2	10%, 25%	Ammonia nitrogen, Phosphorus	Tested daily over a 5-day digestion period
Phase 3	6%, 7%, 8%, 9%, 11%, 12%	Ammonia nitrogen, Phosphorus	Tested daily over a 5-day digestion period

Wastewater was obtained from the Curtin University Sarawak Campus' sewage treatment plant. From previous studies ([2], [20], [21]) the influent and effluent water quality is subject to seasonal variation, but remains reasonably consistent. For this study, each phase of the tests uses the same batch of wastewater sampled when the tests were performed. As the wastewater was obtained during different periods of the year, a control sample of wastewater is always tested together with the dilutions.

All water samples placed in the same location in the laboratory, subject to the same room temperature. Phase 1 of the testing is aimed at exploring the effects of the garbage enzyme on wastewater in general. Therefore, all water quality parameters were tested. From Phase 1 results, it was found that the dilutions of garbage enzyme effectively removed ammonia nitrogen and phosphorus. Therefore, in Phase 2, the degradation of the ammonia nitrogen and phosphorus was studied in more detail. Similarly, a 5-day digestion period was allocated, but daily tests for ammonia nitrogen and phosphorus were carried out to monitor the change of ammonia nitrogen and phosphorus levels in the mixture. Phase 3 tests were aimed at determining the best garbage enzyme dilution in ammonia nitrogen and phosphorus removal within the 5-day digestion period, with tests carried out daily.

III. Results

A. Phase 1 tests

Due to space constraints, the water quality test results are presented in tabular form, in Table 4. The tests were also carried out for pure wastewater (pre- and post-digestion), and pure garbage enzyme. As shown in Table 4, the pH of the wastewater was found to increase to slightly above neutral after the digestion period. Pure garbage enzyme is acidic, with a pH of 3.6. Due to high concentration of garbage enzyme in wastewater, the mixtures were all acidic, except the low dilutions of 5% and 10%. The ammonia nitrogen and phosphorus contained in the domestic wastewater sampled did not reduce after digestion. However, for mixtures of the garbage enzyme with wastewater, no ammonia nitrogen and phosphorus was detected at the end of the digestion period. However, for the low dilution of 5%, some ammonia nitrogen and phosphorus remained at the end of the digestion period. As for BOD_5, its value for fresh wastewater was 42 mg/L, and after digestion BOD decreased to lesser than 8.9 mg/L. These BOD_5 levels are quite low for domestic wastewater, indicating that the wastewater used in this study is of weak strength. However, for mixtures of wastewater with garbage enzyme, the BOD_5 levels increased dramatically, in relation to the increase in percentage of garbage enzyme in the mixture. Further tests for quality control purposes (not presented here due to space constraints) had confirmed that addition of the garbage enzyme increased the BOD_5 levels of the mixture.

From the test results for pure garbage enzyme, it can be concluded that it is acidic, and does not contain ammonia nitrogen, phosphorus, nitrate, and total chlorine. However, due to its effects in increasing BOD, this indicates that it contains high amounts of organic matter, which is to be expected since it is produced with kitchen waste and sugar is used as a fermentation substrate. Therefore, the garbage enzyme will not be useful in BOD removal. However, the addition of the garbage enzyme seems to remove the ammonia nitrogen and phosphorus. As a result, in the second phase, the laboratory tests focused on ammonia nitrogen and phosphorus removal, studying the levels of these two nutrients daily over the digestion period.

Table IV
Laboratory Results for Phase 1Tests

Tests	WW[a]	WW[b]	Pure (100%) garbage enzyme	Dilutions of garbage enzyme in wastewater by volume 5	10	25	50	75
pH	6.9	8.3	3.6	6.4	7	4.2	4	3.8
NH_3 (mg/L)	3.0	3.0	0	2.5	0	0	0	0
P (mg/L)	1.17	1.17	0	1.17	0	0	0	0
BOD_5	42.0	8.9	133.4	57.7	49.5	87.4	114.8	119.2
Total Chlorine (mg/L)	0	0	0	0	0	0	0	0
Nitrate (mg/L)	0	0	0	0	0	0	0	0

[a]Fresh wastewater
[b]Wastewater after the digestion period of 5 days

B. Phase 2 tests

For the Phase 2 tests, the aim was to determine the pattern of removal of ammonia nitrogen and phosphorus, as well as monitor the pH variation of a mixture of wastewater with low concentration of garbage enzyme (10%), against a mixture with high concentration of enzyme (25%). Therefore, the ammonia nitrogen, phosphorus and pH levels were monitored daily over the 5-day digestion period. The pH of the fresh wastewater was 7.2, ammonia nitrogen content was more than 2.5mg/L, phosphorus concentration was 3.33 mg/L, BOD_5 was 43.5 mg/L and no concentrations of total chlorine and nitrate was detected. Figure 1 shows that the pH for the 25% dilution of garbage enzyme in wastewater did not increase, and remained acidic due to the high amount of garbage enzyme in the wastewater. However, for the 10% dilution, the pH increased starting from day 4 to the neutral range. This corresponds with the observation in Phase 1, where the pH for the 10% dilution returned to neutral.

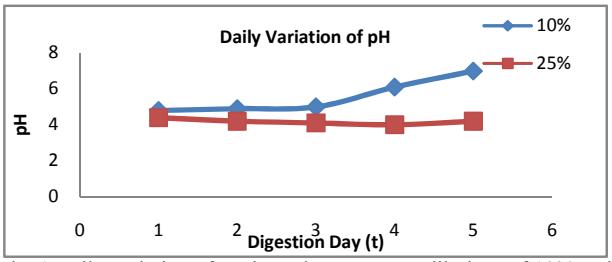

Fig. 1 Daily variation of pH in garbage enzyme dilutions of 10% and 25% in wastewater

The degradation of ammonia nitrogen is presented in Figure 2. For both the 25% and 10% dilution, the ammonia nitrogen concentration had been significantly decreased by the third day, and totally removed by the fifth day of the digestion. For the 25% dilution, the ammonia nitrogen decreases rapidly on the first two days. The rate of degradation then slowed by the third day. By the fourth day, the ammonia nitrogen had been totally removed in the 25% dilution. As for phosphorus (Figure 3), both dilutions had removed the phosphorus content by the first day.

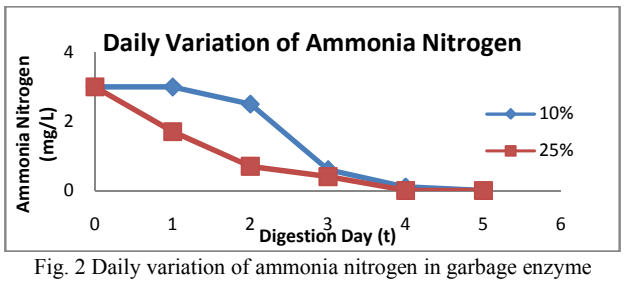

Fig. 2 Daily variation of ammonia nitrogen in garbage enzyme dilutions of 10% and 25% in wastewater

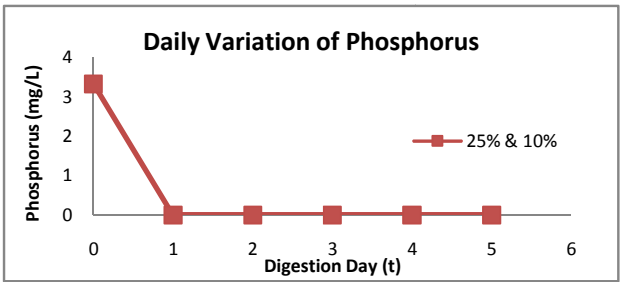

Fig. 3 Daily variation of phosphorus concentration in garbage enzyme dilutions of 10% and 25% in wastewater

The results suggest that the removal of ammonia nitrogen and phosphorus is quite promising with the 10% and 25% dilutions of the garbage enzyme in wastewater, confirming the results for the removal of these nutrients in Phase 1 tests. However, for the 25% dilution, the pH remained acidic by the end of the digestion period. In this respect, the 10% dilution might be a better choice in the removal of these nutrients, as the mixture returned to the neutral range of pH after the digestion period. Thus, Phase 3 of the laboratory experiments were aimed at determining the removal of ammonia nitrogen and phosphorus, and pH variation over the 5-day digestion period, with a range of dilutions of garbage enzyme in wastewater, from 6 – 12%.

C. Phase 3 tests

For phase 3, dilutions of 6%, 7%, 8%, 9%, 11% and 12% were tested. The 5% and 10% dilutions were not tested as they had been tested earlier. The fresh wastewater used for all of the tests has a pH of 7.6, ammonia nitrogen content of 3 mg/L, and phosphorus content of 4.33 mg/L. Total chlorine and nitrate still remained at 0 mg/L. This wastewater batch was used for all the subsequent tests.

For pH variation (see Figure 4), two trends were observed for all the dilutions. For the 6 – 8% dilutions, the pH increased gradually until the third day of digestion, where a drastic increase from about pH 5 to pH 7 was observed. The pH rose to about 7.5 by the end of the digestion period. As for the 9%, 11% and 12% dilutions, a slight drop in pH is observed on the third day, before a rapid increase to pH 7 is observed.

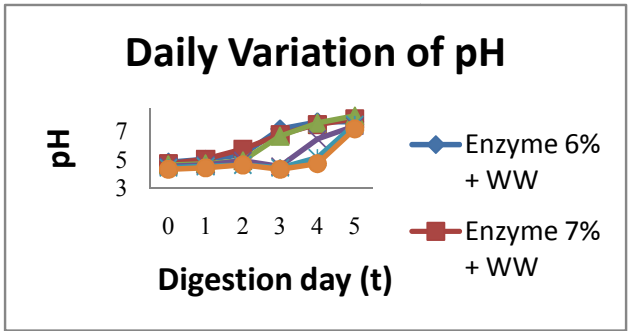

Fig. 4 Daily variation of pH in garbage enzyme dilutions of 6 – 9%, and 11 – 12%

For ammonia nitrogen removal (see Figure 5), the same two trends for the various dilutions as for pH variation can also be observed. During the first two days of the digestion period, the ammonia nitrogen remained at 3mg/L, before a drastic reduction on the third day. However, on the fourth day, the ammonia nitrogen concentration increased. The 6% and 7% dilutions increased to 2.5 mg/L, and the 8% dilution to about 1.4 mg/L. The reason for this increase in ammonia nitrogen is unclear. Similarly, for the 9%, 11% and 12% dilutions, the same trend of ammonia nitrogen degradation was observed. The ammonia nitrogen concentration reduced drastically on the fourth day. A slight increase in the ammonia nitrogen concentration was observed for the 9% dilution, but it was not as significant as the increase observed for the 6 – 8% dilution group. The ammonia nitrogen concentration had reached 0 mg/l for the 11% and 12% dilutions by the fourth day of digestion.

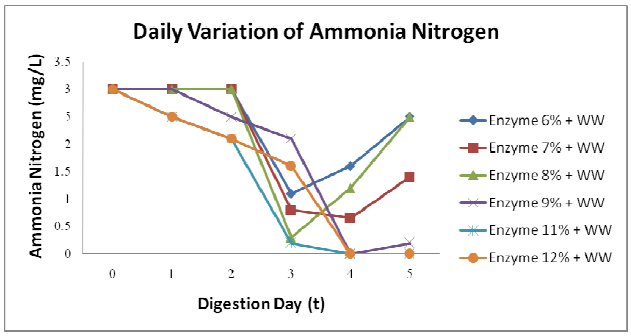

Fig. 5 Daily variation of ammonia nitrogen concentration in garbage enzyme dilutions of 6 – 9%, and 11 – 12%

As for phosphorus reduction (see Figure 6), increases in the phosphorus concentration for all the dilutions were observed, but mostly reached a low level (close to 0mg/L) by the end of the digestion period. The 6% and 7% dilutions indicated the same trend of degradation of phosphorus. The phosphorus concentration decreased rapidly, and almost reduced to 0mg/L on the third day. However, it increased very slightly on the fourth and fifth days. This increase was more pronounced for the 8% dilution, where an initial increase to 6.33 mg/L was also seen on the first day. For the 9% dilution, the phosphorus concentration had reduced to 0mg/L on the second day, before a slight increase, and ending close to 0mg/L by the end of the digestion. For 11% and 12%, a minimal increase was observed on the fourth day.

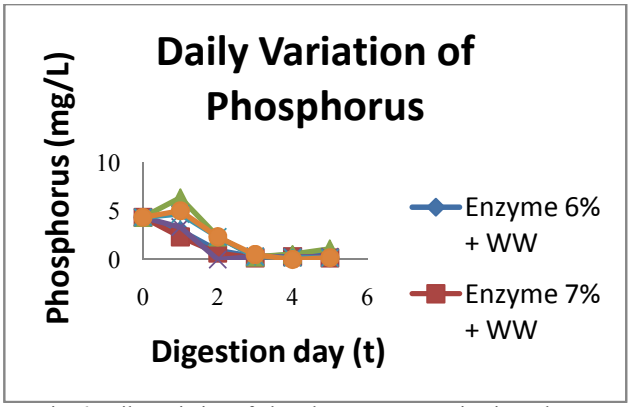

Fig. 6 Daily variation of phosphorus concentration in garbage enzyme dilutions of 6 – 9%, and 11 – 12%

IV. Summary

The Phase 1 tests indicate that higher dilutions of garbage enzyme resulted in a more acidic solution. The results also indicated that ammonia nitrogen and phosphorus had been removed by garbage enzyme. However, due to the high amount of organic material in the garbage enzyme, an increase in BOD was observed. This indicates that the garbage enzyme is effective in removing ammonia nitrogen and phosphorus, but not BOD, and thus is an unsuitable additive for the removal of BOD in wastewater treatment. Daily monitoring from Phase 2 tests indicated the removal pattern of the ammonia nitrogen and phosphorus, and for a dilution of 10% garbage enzyme, the pH of the solution returned to neutral after the digestion period. This indicates that high levels of garbage enzyme suppressed the pH of the mixture at the acidic range. From Phase 3 tests, an increase in the ammonia nitrogen and phosphorus levels (more significant for ammonia nitrogen) was observed within the 5-day digestion period. The reason for this increase is unclear. Phase 3 tests indicated that the most economic dilution for removal of ammonia nitrogen and phosphorus was 9%. With 9% dilution, the pH of the solution also returned to neutral. This suggests that a 9% solution of garbage enzyme could be favourable for removal of ammonia nitrogen and phosphorus in wastewater treatment.

V. Conclusion

From the study, the garbage enzyme produced with recipes and methodology published in the media was acidic, and contained a large amount of organic material which resulted in a high BOD. It did not contain ammonia nitrogen, nitrates, chlorine, or phosphorus. The results indicate that the garbage enzyme can remove ammonia nitrogen and phosphorus in wastewater dilutions. A 9% solution of garbage enzyme in wastewater was found to be most economic in removing ammonia nitrogen and phosphorus, and in neutralizing the wastewater, within the digestion period of 5 days. However, the addition of the garbage enzyme increased the BOD of the wastewater, in proportion with the amount of garbage enzyme added. It is suggested that the garbage enzyme could be used as an additive in wastewater treatment, to remove ammonia nitrogen and phosphorus. However, the mechanism for the removal of these nutrients is unclear, and detailed tests and further study would be required to provide an explanation. In a study to be published in future, the effects of the garbage enzyme on the microbiological characteristics of the wastewater is explored. More importantly, characterization of the garbage enzyme to reveal its constituents is a critical step for any future studies

All wastewater used for tests are taken from Curtin Sarawak's wastewater treatment plant, and tested in the laboratory within two hours. Based on control samples of wastewater for each phase of the tests, variation was observed for the influent phosphorus concentration. It is suggested here that the concentration of phosphorus depends on the population of the Curtin University campus. Due to a higher population of people in campus, frequent cleaning results in more detergent content in the wastewater. A source of phosphorus is detergent used in cleaning. The wastewater from Curtin's wastewater treatment plant is found to be quite consistent, having same constituents and similar concentration.

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