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Application of Bio-Enzyme in Wastewater (Greywater) Treatment

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Abstract - *With rapid industrialization and ongoing development activities by humankind has polluted the water and reduced the quality of water at such a level that it becomes a threat to life. Since, water is an essential element for nature as well as for humans to perform various tasks to run the continuous cycle of survival. It becomes very much essential to make it pure. In past few years, researchers are working to find new techniques for reclamation of water focusing on biological or physical wastewater treatment methods rather than chemical ones. Use of bio-enzyme in biological treatment of wastewater could be a viable and eco-friendly solution. In this study bio-enzyme obtained from fermentation of flower waste was used to treat the wastewater (greywater) sample. The wastewater samples were digested for a period of 5, 15 and 25 days by mixing with 5%, 10% and 15% bio-enzyme solution. The parameters like pH, TDS, BOD_5, COD, Ammonia Nitrogen and Phosphates were analyzed for present investigation. The results showed that bio-enzyme can remove TDS, BOD_5 and COD characteristics of the wastewater; while complete removal of ammonical nitrogen and phosphate was observed with low concentration of bio-enzyme solution. No considerable variation in the characteristics pH was noted; it remains acidic. Bio-Enzyme can be used as an economic option to enhance wastewater attributes by treating it with bio-enzymes and make fit it for various purposes. Moreover, utilization of bio-enzymes can also help in checking disposal of chemicals during wastewater treatment processes making it environmentally sustainable.*

Key Words: Bio-Enzyme, Garbage Enzyme, Greywater Treatment, Waste Enzyme, Wastewater Treatment

1. INTRODUCTION

More than 70 % of the fresh water bodies carrying polluted water and ground water level have been reduced to zero at certain places[1]. The water which gets contaminated or polluted lost its usefulness and become a waste; such water generally termed as wastewater. Wastewater contains a wide range of elements that could impact environmental and public health negatively. To minimize potential harmful impacts, it is highly recommended that wastewater must be treated prior to discharge or reuse. Various treatment and purification technologies have been developed to reclaim the usefulness of wastewater. These treatment technologies are based on three basic processes i.e. Physical, chemical and biological[2]. For treatment of the wastewater which generally contains a high amount of organic content, biological treatment is most suitable option. Biological processes require an ample amount of time for treatment which cannot fulfill the daily demand of water. So, it becomes necessary to accelerate the rate of reaction by some means. For effective and efficient treatment of wastewater using biological treatment, enzymes could be the solution[3]. Enzymes not only act as catalyst moreover they increase the rate of reaction many folds with less energy in desired direction to get desired output, if properly used.

To perform various metabolic functions living cells produces biocatalyst that performs specific bio-chemical action/response very much needed for flourishing life. These biocatalysts are called as enzymes[4]. Enzyme is the natural liquid formulation extracted from fermentation of vegetable/fruits which does not catch fire/ cause corrosion and non-poisonous in nature[5]. An enzyme shows attributes that make their utilization favorable when contrasted with conventional chemical catalysts. Enzymes are particular for their substrates and catalyze just one or few bio-chemical reactions among numerous probabilities[6]. The enzymes being for the most part proteins and peptides; they are degradable by microorganisms and effortlessly expelled from adulterated streams without causing any disposal issues. Enzymes utilized in wastewater fall in the category of biological supplements[7].

Enzymes produced under anaerobic conditions from fermentation of organic waste material such as fruit/ vegetable waste along with brown sugar and water in a fixed proportion are called as Bio-Enzymes or Waste Enzyme or Garbage Enzymes[8]. Bio-Enzymes or waste enzymes or garbage enzymes are different than any other enzymes which are produced by a living cell or microorganism such as fruit enzymes[9]. Fruit enzyme can be used in edible products or is edible while on the other as bio-enzymes are not fit for human consumption. Bio-Enzyme can be utilized for natural household cleaning; as natural insecticides; replacement of chemical detergent; as body care; as natural antiseptic for houses, as organic fertilizer; removing odour and toxic air released from smoking, car exhaust, chemical resides from household products, etc., and it also prevents blockage of drainpipes, helps in purifying the water bodies when flows them. It also acts as repellent for mosquitoes, flies, rats, cockroaches and other nuisance creating organisms[10]. Effective treatment of wastewater can be done by utilizing bio-enzymes[11].

For the treatment of domestic wastewater with advanced level of degradation in a shorter span of time, bio-enzyme performs the same task as done by enzymes. In Malaysia, many researchers have performed investigation to check the bio-enzyme as viable solution for wastewater treatment[12].

In India, bio-enzyme is not much known and practiced at very low level[10]. Usage of bio-enzyme not only provides an alternative solution to biological recovery from organic waste it will also help in minimization and reduction of waste; since municipal solid waste mainly consists of organic waste. It also puts a check on greenhouse emissions, lessen the burden on landfills[13].

This paper presents the results from digestion of greywater using bio-enzymes produced from flower waste at three different concentrations i.e. 5%, 10% and 15% after 5, 10 and 25 days of digestion period. An attempt has been made to understand the effectiveness of bio-enzymes produced from organic waste material in treating wastewater specifically greywater.

2. MATERIALS AND METHODS

2.1 Materials

The materials used in this study are:

- Flower waste (fresh)
- Jaggery (chemical free)
- Water (free from any kind of impurity)
- Plastic container with screw cap (preferably)
- Aluminium foil

All the materials was collected as specified above and in sufficient quantity as per requirement

2.2 Methods

Methodology followed in the present study can be divided in two main steps:

(i) Bio-Enzyme preparation
(ii) Wastewater treatment using bio-enzyme

2.2.1 Preparation of bio-enzyme

Flower waste in required quantity was collected as organic substances to make enzymes. After the collection of waste separation is done to ensure no any chemical substance enter in to the system which can affect the process. Flower waste was then shredded in small pieces to increase surface area for reaction. It is done to increase the rate of decomposition. Jaggery, flower waste and water were mixed together in the ratio of 1:3:10 to prepare waste enzyme or bio-enzyme [14]. The mixing process was done in an air-tight plastic container which can expand and has screw bottle caps. Gases will get formed during production of waste enzyme so plastic container with screw caps such as plastic bottle is the best alternative for releasing the gases so produced. Then the container was kept at safe place so no one can disturb the digestion process; where the food waste is broken down into smaller compounds by microbes along with the release of gases under fermentation process. To release gases lid was opened once in a day, for a minute or so, then the lid was put back on, it was kept back in the dark place and the same procedure was repeated on another day (for first one month at least).

After third week onwards, the gas production was reduced a bit. In the second month, lid was opened on end of the week for first two weeks as gas release was reduced considerably and again it was kept in the dark. After completion of 45 days, the container was tightly closed and left it for another 45 days of digestion. The total duration to complete the process was 3 months, as recommended in the previous studies [15].

After 90 days of digestion a brown colored liquid along with many small particles and some undigested residue was prepared in the container. That brown colored liquid was raw enzyme and it was needed to separate it out from other solid matter left after digestion. Filtration was done to obtain the prepared bio-enzyme or waste enzyme with enhance the structural, functional properties. Filtered bio-enzyme solution was kept separately in closed container. The characterization of the bio-enzyme was done immediately, after 30 and 60 days of filtration to know the stability of the enzyme solution [16].

2.2.2 Wastewater treatment using bio-enzyme

When the characterization of bio-enzyme was over then the wastewater (greywater) sample are collected after from a drain where wastewater doesn't contain excreta. After collection of raw wastewater sample it was analyzed to know its initial characteristics. Then nine beakers was filled the wastewater sample mixed with bio-enzyme or flower waste enzyme solution in different proportion i.e. 5%, 10%, and 15%[10]. Each three beakers having wastewater sample mixed same concentration of bio-enzyme was prepared for 5, 15 and 25 days of digestion. The change in the characteristics of the treated wastewater sample after digestion period of 5, 15 and 25 days, were analyzed and noted[17].

3. RESULT & DISCUSSION

In present study, different tests were carried out in batches to determine the effective dosage of flower waste enzyme for treatment of greywater sample. The parameters like pH, TDS, BOD_5, COD, Ammonia Nitrogen and Phosphate were analyzed for all the samples as per procedures in standard methods[18]. The characteristics of flower waste enzyme solutions were analyzed immediately after filtration, 30 days after filtration and 60 days of filtration. For present study, 5%, 10% and 15% of flower waste enzyme after 60 days of filtration with wastewater (greywater) sample were selected. Total nine beakers were filled by wastewater sample along with 5%, 10% and 15% enzyme solution obtained from fermentation of flower waste. These beakers were covered with a foil of aluminium and were kept for digestion period of 5 days, 15 days and 25 days. The variations in characteristics of the wastewater sample after 5, 15 and 25 days of digestion were observed and analyzed.

3.1 Characteristics of Bio-Enzyme/Waste Enzyme

The characteristics of enzyme solution for flower waste after three months of fermentation period was noted; immediately after filtration of the enzyme solution, 30 days after filtration and 60 days after filtration. The waste enzyme solution is rich in organic content. The characteristics of the bio-enzyme extracted out of flower waste in tabulated below (Table 1).

Table -1: Characteristics of Flower Waste Enzyme

Parameter	Just after filtration	30 Days of filtration	60 days of filtration
PH	3.09	3.41	4.01
TDS (mg/L)	2012	1415	1012
BOD5(mg/L)	1252	535	83
COD(mg/L)	44620	2523	153
Ammonical Nitrogen (mg/L)	0	0	0
Phosphate (mg/L)	0	0	0

The low pH value of the bio-enzyme solution prepared from flower waste shows its acidic nature. The BOD_5 and COD values were high when the enzyme solution was analyzed immediately after filtration of the solution. But after 30 days of filtration, BOD reduced to less than half of initial concentration and COD concentration came to level of less than 10%. Moreover, After 60 day of filtration of enzyme solution, drop of more than 90% and about 99% in BOD and COD concentration respectively.

3.2 Characteristics of Raw Wastewater (Greywater) Sample

Before treating the wastewater sample with bio-enzyme, it is essential to find out the characteristics of the raw wastewater sample. The parameters like pH, TDS, BOD_5, COD, Ammonia nitrogen and Phosphates were found out. Table 2 demonstrates the raw wastewater characteristics used in present study.

Table -2: Raw wastewater (greywater) characteristics

Parameter	Units	Value
PH	--	6.16
TDS (mg/L)	mg/L	563
BOD5(mg/L)	mg/L	192
COD(mg/L)	mg/L	290
Ammonical Nitrogen (mg/L)	mg/L	9.6
Phosphate (mg/L)	mg/L	110

3.3 Characteristics of the Wastewater Sample after Treatment with Bio-Enzyme

The raw greywater sample was treated using 5%, 10% and 15% bio-enzyme solution obtained from flower waste. These samples were then left for 5, 15 and 25 days. The variations of phosphate, ammonical nitrogen, COD, BOD5, TDS and pH with time for different concentrations of bio-enzyme solution were analyzed and discussed below:

- ***pH***

After treatment with bio-enzyme the variations was observed in pH value of the effluent and the corresponding variation in the characteristic of treated wastewater sample after 5, 15 & 25 days of digestion are shown in figure 1.

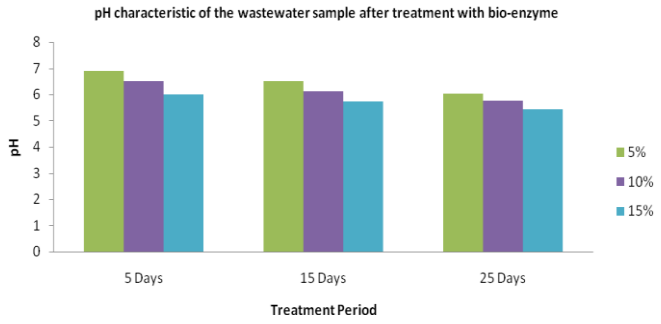

Fig -1: Variation in pH characteristic of the treated wastewater sample

The filtered bio-enzyme obtained from flower waste was found acidic in nature as indicated by low its pH value (see Table 1). When it get mixed with greywater, the pH of wastewater sample having 5% bio-enzyme for digestion of 5 days, increased to nearly neutral range due to enzymatic reactions but slowly get reduced at constant rate with increase in digestion period. Similar variation is also noted for wastewater samples having 10% and 15% bio-enzyme mixed.

- ***TDS***

After treatment with bio-enzyme the variations was observed in TDS content of the effluent and the corresponding variation in the characteristic of treated wastewater sample after 5, 15 & 25 days of digestion are shown in figure 2.

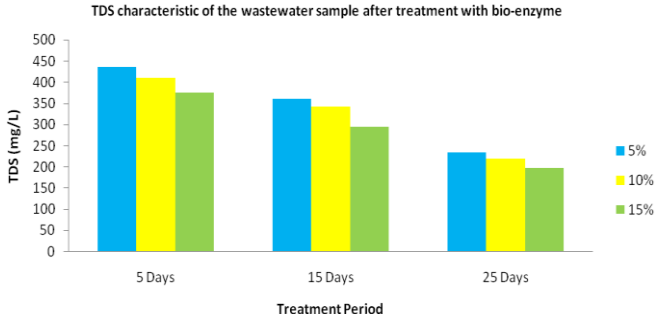

Fig -2: Variation in TDS characteristic of the treated wastewater sample

TDS characteristic of wastewater sample mixed with 5% bio-enzyme for digestion of 5 days, 15 days and 25 days was noted with decrement at constant rate; When compared with initial TDS of raw wastewater sample (see Table 2) more than 50% TDS got removed after 25 days of digestion due to enzymatic reactions. Similar, variation is also noted for wastewater samples having 10% and 15% bio-enzyme mixed.

➢ *BOD_5*

After treatment with bio-enzyme the variations was in the BOD_5 characteristic of treated wastewater sample after 5, 15 & 25 days of digestion are shown in figure 3.

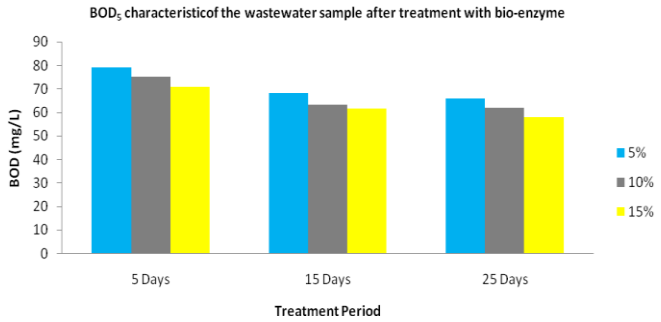

Fig -3: Variation in BOD_5 characteristic of the treated wastewater sample

In BOD_5 characteristic of wastewater sample with all three concentrations (i.e. 5%, 10% and 15%) of bio-enzyme, a constant rate of reduction in BOD_5 was noted for digestion of 5 days, 15 days and 25 days. Reduction was more than 50% for digestion period of initial 5 days. While this rate falls down below less than 10% for next 10 and 20 days.

➢ *COD*

The variations in COD characteristic of the treated wastewater sample after 5, 15 & 25 days of digestion with bio-enzyme are shown in figure 4.

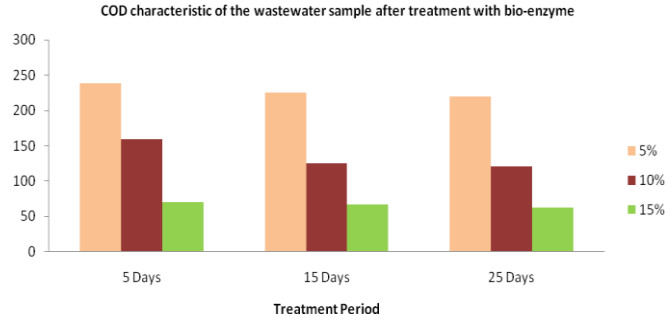

Fig -4: Variation in COD characteristic of the treated wastewater sample

A decrease of about 20% can be observed in COD characteristic of wastewater sample (see Figure 3.4) mixed with 5% of bio-enzyme for 5 days, 15 days and 25 days of digestion. While on mixing 10% and 15% bio-enzyme solution with wastewater sample a sharp removal rate was observed.

➢ *Ammonical Nitrogen*

The variations in ammonical nitrogen characteristic of the treated wastewater sample after 5, 15 & 25 days of digestion with bio-enzyme are shown in figure 5.

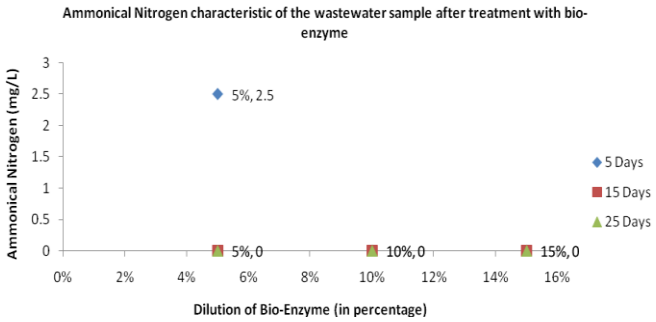

Fig -5: Variation in ammonical nitrogen characteristic of the treated wastewater sample

More than 70% of the ammonical nitrogen was removed of the wastewater sample mixed with 5% bio-enzyme for digestion of first 5 days. While 100% removal rate was observed for wastewater sample mixed with 10% and 15% bio-enzyme solution for first 5 days of digestion.

➢ *Phosphate*

The variations in phosphate characteristic of the treated wastewater sample after 5, 15 & 25 days of digestion with bio-enzyme are shown in figure 6.

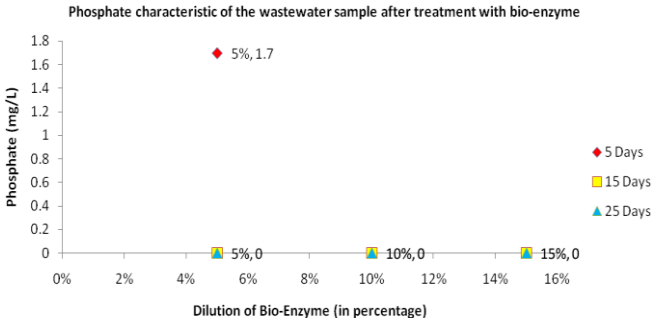

Fig -6: Variation in phosphate characteristic of the treated wastewater sample

In case of phosphate characteristic, more than 95% removal was observed for wastewater sample mixed with 5% bio-enzyme solution for digestion of first 5 days. While 100% removal rate was observed for wastewater sample mixed with 10% and 15% bio-enzyme solution for the first 5 days of digestion.

4. CONCLUSIONS

In present study, the bio-enzyme was produced from organic waste material i.e., flower waste. The bio-enzyme showed acidic character and high initial BOD due to the presence of high amount of organic content. The results indicate that the 10% bio-enzyme solution may effectively remove ammonical nitrogen, phosphate, TDS, BOD_5 and COD characteristics of greywater. Bio-Enzyme is cheap and cost effective as it is

obtained from waste material. Moreover, it reduces the burden on planet by utilizing the waste as resources. Hence, Bio-Enzyme can be can be used as an economic option to enhance wastewater attributes to make it fit for further utilization.

Furthermore investigations can be done to find out the suitable additives or activators or enhancer on enzyme action. Investigation on pre-treatment for the reduction of high initial BOD and COD prior to action of enzymes can also be studied. The utilization of bio-enzymes in treating all types of wastewaters under different physico-chemical conditions can also be explored. The effect of bio-enzymes on characteristics of wastewater other than or along with the parameters discussed in present study can also be investigated.

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