

Preparation and Applications of Bio-enzyme: A dual sustainable approach towards rejuvenation of water bodies and food waste management

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ABSTRACT

The present article highlights a dual sustainable approach towards the rejuvenation of water bodies and food waste management by utilizing bio-enzymes and its byproducts. Environmental pollution is rising drastically due to excessive use of harmful chemicals causing degradation of our ecosystem. Most of these chemicals are often found in water bodies even after sewage treatment and possess harmful threats on the environment as well as on the human body. The use of bio-enzymes, organic solutions made from citrus fruit peels through a natural process, can be considered as an eco-friendly as well as cost effective solution to these hazardous chemicals. We attempt here to demonstrate how to restore and rejuvenate water bodies using bio-enzymes prepared from Citrus Fruit peels and tried to explore how it affects water quality parameter indices, such as, hardness, alkalinity, chloride ion concentration etc. Water quality parameters are measured for water samples with and without the bio-enzyme at different time intervals. Our study shows a marked improvement in the water quality parameters that not only reveals the potential use of the bio-enzyme on water treatments but also enables the whole treatment to be cost effective and eco-friendly. Moreover, the organic residue derived during the preparation of bio-enzymes can be further used as good quality manure which can improve the soil quality instead of using harmful chemical fertilizer and thus demonstrates an efficient and effective way towards the management of food wastes across the ecosystem.

Keywords: Bio-enzyme, citrus fruit peels, food waste management, sustainability, rejuvenation, bio-remediation

INTRODUCTION

Bio-enzymes are organic solutions containing beneficial bacteria which helps to digest stains, waste, foul odors as well as in removal of the harmful microbes. In recent times bio-enzymes have found to be very much useful in achieving sustainable future and thus have gained huge popularity across the globe. Bio-enzymes are conventionally prepared by fermenting domestic organic wastes, such as citrus fruit and vegetable peels [1]. Bio enzymes are found to be very much effective in breaking down the organic wastes and thus have potential multipurpose cleaning activities which make it an extremely good replacement for the hazardous chemicals that we often use in our daily household purposes to clean toilets, floors, etc. Prolonged use of easily available popular commercial cleaning agents, like various detergents, phenyl etc. contains extremely harmful and toxic chemicals, such as, Sodium lauryl sulphate, phenolic compounds etc. that results in various health issues like skin disease, poor immunity, nausea, eye and throat irritation as well as cancer. Moreover, frequent use of detergents release phosphate ion (PO_4^{3-}) which enhances the possibility of Eutrophication in water bodies and thus creates detrimental impact on the whole eco-system [1]. These chemicals further harm the environment by causing air pollution, degrading aquatic life and thus results in an imbalance to the global ecosystem.

Moreover, depletion of groundwater resources day by day has added an extra risk on the biosphere which is also an important concern across the present global scenario. Thus restoration and rejuvenation of water bodies have become important sustainability issues that require initiatives to analyze and improve water quality parameters by effective emerging waste water treatment methodologies. Beside chemical treatments, uses of eco-friendly processes such as, treating the water samples with bio-enzymes have also been found to be a promising technique [2] to solve the present crisis. Thus, bio-enzymes can also be effectively used to improve the water quality parameters thereby making them a cost effective bio-remediator. On the other hand, the organic residue that is obtained during the processing and

separation of bio-enzymes from the reaction mixture after the desired incubation period has been found to be very high quality bio-manure which can effectively resist/reduce soil erosion. Thus the multipurpose applications of bio-enzymes and the bio-fertilizer derived from the organic residue of bio-enzyme containing solution mixture can lead us to new horizons towards food waste management and rejuvenation of water bodies to achieve sustainability.

We use citrus fruit peels that were fermented in presence of jaggery and requisite amount of water to prepare bio-enzyme [3] that has been found to improve the quality parameters of water samples collected from water bodies adjacent to our college premises (Figure 1). The study of the effectiveness of the enzyme over the quality parameters of the collected water samples has been measured by standard measurement techniques and the trends in the values of Hardness, alkalinity, Chloride ion concentration, dissolved oxygen, pH etc are reported to support our claim. Additionally we use the organic residue collected after the successful filtration of the enzyme from the incubated mixture as effective manure and thus attempt to demonstrate an effective way towards food waste management issues [4].

BIO-ENZYME PREPARATION AND INITIATION OF FOOD WASTE MANAGEMENT

Bio-enzyme is produced by the anaerobic fermentation of citrus fruit peels in presence of jaggery and water. Large container with screw cap is preferred to store the mixture. Usually this mixture is kept in dark for 90 days and the gas resulting from the fermentation process inside the closed container is occasionally released by opening the container cap in regular intervals during the whole preparation process [5]. After a month gas production is reduced so, cap is opened once in the end of a week. An orange color liquid (Figure 2) is obtained after completion of 90 days with some particles and undigested precipitate in the container. The liquid obtained after filtration in the container contains bio-enzyme [3], the alcohol and the protein content of the solution were found to be ~4% and 120 ppm, respectively. The resulting liquid is filtered through a Buchner Funnel using Whatmann 40 filter paper and the organic residue separated is dried under sunlight and later used as the bio-fertilizer. The bio-fertilizer is applied to the plants and the growth is monitored.

APPLICATIONS OF BIO-ENZYMES

A. Bio-enzyme as water quality enhancer

Application of bio-enzyme (prepared from Citrus Fruit peels) in the waste water affects the water quality parameters like hardness, chloride ion concentration, dissolved oxygen etc. There is a marked change in the water quality parameters that proves the potential use of the bio enzyme on waste water treatments and also fostering the whole treatment to be cost effective and eco-friendly.

Hardness

Water sample was collected from water body adjacent to our college campus and hardness was measured before and after the addition of the mixture containing bio-enzyme. Noticeable change of hardness was observed after the introduction of the bio-enzyme in the water sample. Initially the hardness of the water sample was measured as 336 ppm and after the addition of the mixture containing bio-enzyme to the sample water the sample was preserved in the dark. The hardness was again measured in regular interval of 7 days and finally the hardness came down to 248 ppm after 21 days. This result suggests that the prepared bio-enzyme can be used as a water softener.

Cl⁻ ion concentration

Natural occurrence of chloride ion in water sample is not harmful for human health [4] as it is used as the disinfectant in the water treatment plants. The change of chloride ion concentration of the sample water was found to be from 470 ppm to 143 ppm (permissible limit of chloride ion concentration for drinking water is 250 ppm [4]) after treating the water sample with bio-enzyme containing solution mixture. The change was observed after preserving the water sample with bio-enzyme for 21 days.

Alkalinity

Water becomes alkaline due to the presence of some soluble bases like NaOH, KOH and salts like Na₂CO₃, K₂CO₃, NaHCO₃ etc. Alkalinity of water can easily be measured by using standardized (N/50) H₂SO₄ solution. After the introduction of bio-enzymes, the alkalinity was monitored in regular interval of time of 7 days. After 21 days the alkalinity of the sample water was found to be decreasing from 674 ppm to 410 ppm.

Total Dissolved Solid (TDS)

Total Dissolved Solid is determined with the help of a commercially available TDS meter. The study was done both before and after the introduction of bio-enzymes into the water sample. In this case also the TDS value showed a decreasing trend from 579 ppm to 461 ppm after 21 days. This result also supports that the prepared bio-enzyme is able to enhance the quality of the water sample.

pH

The pH of the water sample was also measured with the help of a commercially available pH meter. The study suggests that the addition of bio-enzyme into sample water does not vary so much. The pH decreases slightly from 8.2 to 7.5 after 7 days from the introduction of bio-enzyme and remains almost invariant even after 21 days.

Dissolved Oxygen (DO)

Dissolved oxygen (DO) of the water sample was measured by Winkler's method before and after the introduction of bio-enzyme. It was observed that the DO value increased from 3.4 ppm to 5.1 ppm after 21 days. This result also supports that the bio-enzyme treatment enhances the quality of the water sample.

B. Bio-enzymes as insecticides and pesticides

Bio-enzymes are always having more valuable benefits than chemical analogues. Bio-enzyme can replace insecticides and pesticides and thus plays an important role in the agricultural field [1], [6]. Bio-enzyme acts as natural pest repellents, while adding water to it helps to propel germ or disease-causing elements as cockroaches, mosquitoes, rats, flies, microbes etc. Sprinkling bio-enzyme at our home can reduce bad odour and dampness of the floor without causing any health hazards. Farmers can use bio-enzyme as replacement of chemical pesticides and herbicides as it helps in controlling infection of crops and plants and removal of weeds without making any chemical pollution.

C. Household cleaning

Chemical household cleaning products are something which is regularly used by most of us in daily life. Because of their ease of availability as well as ease of use, these products are thought to be of extreme usefulness. However, the problem that many of us do not realize is that these cleaning products are made up of severely toxic chemicals which can cause severe harm to our health as well as our surrounding environment. The chemicals present in these products are often found to cause skin diseases, eye irritation, nausea and various other health-related problems [4]. On the other hand, bio-enzymes which are completely free from harmful chemicals are found to be the best replacement for household cleaning products. Because of the absence of harmful chemicals in them, they cannot cause any type of health-related issues. In addition to this, they also do not cause any harm to our environment. When added to water in an appropriate amount, bio-enzymes can be used to kill disease-causing bacteria and to repel insects. Garbage collection areas and outdoor dumpsters are a common source of odors that can be addressed with using bio-enzyme products [7]. Since bioenzymes provide multiple benefits without causing any harm to the environment and our health, they can be considered as better alternatives compared to other household cleaning products.

FOOD WASTE MANAGEMENT

Due to ever increasing population in the recent time, disposal of waste has become a major issue, especially in urban areas. The places near the garbage landfills are often found to have extremely foul smell which becomes a problem for the people living in the nearby areas. A smart and eco-friendly way of disposal of municipal solid wastes is by converting our daily food stuffs into bio-enzymes. These bio-enzymes not only reduce solid wastes drastically but also control the bad odor which surrounds most of the garbage dumps as well as garbage collecting vehicles. Also, by preparing the bio-enzyme, we can effectively cut down the cost of waste disposal as most of the land fields in India are covered by organic wastes.

A. Preparation of Organic Manure

The organic residue that remains after the filtration of bio-enzyme containing solution from the reaction mixture can be used as natural fertilizers without using pesticides and thus plays a very crucial role in agricultural field. Inorganic fertilizers have high concentration of Nitrogen which lowers the pH of soil thus resulting into highly acidic topsoil. Due to increased acidity in soil crop production is greatly hampered. From different survey site it has been observed that inorganic fertilizers have serious adverse effects on soil such as, soil erosion, soil infertility, contamination of groundwater (leaching), soil friability, mineral depletion, loss of vital nutrients, decreased nutrients absorption and generation of microorganism. On the contrary, organic manure has the ability to transform barren land into fertile farm by converting soil ammonia into nitrate, thus making lands favorable for farming. Dilute bio-enzyme also acts as highly lucrative organic liquid nutrient for soil. Thus the organic manure derived from the dry residue of the fermented mixture is found to have an inherent quality to be used as bio-fertilizer to deal with the snags of chemical fertilizers.

Organic manure contains weak acids like, humic acid, amino acid derived from protein fractions and vitamin B complex and thus acts as an eco-friendly soil supplement containing growth stimulants. It promotes uniform growth and development of the plants, flower and fruit. The presence of proteins and different amino acids makes it more powerful immunity developer helping to develop resistance against pests and diseases.

a. Figures and Tables

Table 1. Water Quality Parameters: Before and after the introduction of bio-enzyme

Parameters	Before introduction of bio-enzyme	After the introduction of the bio-enzyme		
		7 days	14 days	21 days
Chloride content	470 ppm	215 ppm	192.76 ppm	143.3 ppm
Hardness	336 ppm	326 ppm	294 ppm	248 ppm
Alkalinity	674 ppm	577.5 ppm	523.65 ppm	410 ppm
pH	8.2	7.5	7.5	7.5
Total dissolved Solid	579 ppm	520 ppm	480 ppm	461 ppm
Dissolved oxygen	3.4 ppm	4.8 ppm	5 ppm	5.1 ppm



Figure 1. Water body adjacent to our college campus from where water sample was collected for WQI checking

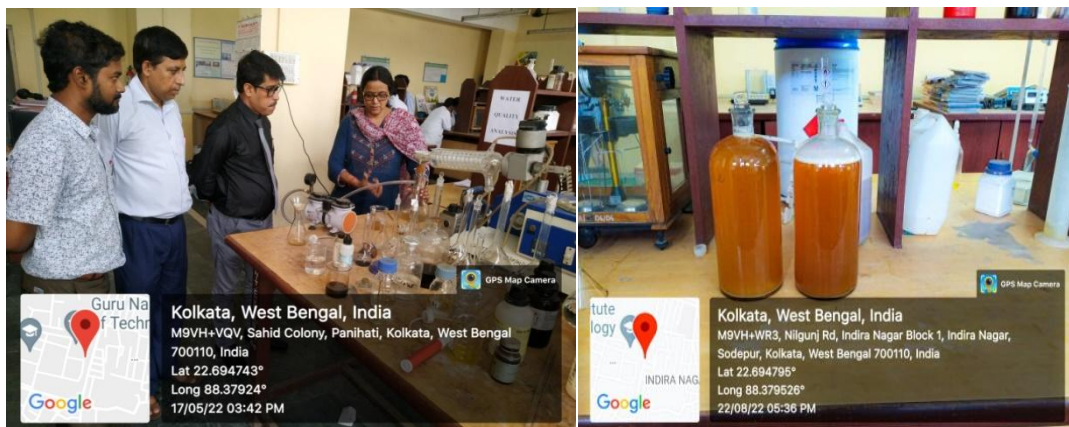


Figure 2. Separation of solution containing bio-enzyme was going on (left) and the final solution containing bio-enzyme (right)

CONCLUSION

Water bodies play a very significant role as wetland ecosystem and thus fall under the Wetland Conservation and Management Rules 2017. Our present work thus attempts to restore and rejuvenate the water bodies, adjacent to our college campus, which may have important role as potential aquatic ecosystem. The different water quality parameters for the water sample collected from the water bodies were checked thoroughly. The same parameters were rechecked after treating the samples with bio-enzymes prepared from citrus fruit peels. The comparative results are reported with possible explanations that clearly indicate that bio-remediation for the water bodies can be effectively carried out by spraying the solution of bio-enzymes after cleaning up garbage from the sites. Bio-enzymes are found to be very effective in rapid digestion of organic pollutants in water bodies and thus lead to a productive and cost effective way to restore and rejuvenate the water bodies instead of using harmful chemicals that sometimes possess severe threats to whole biosphere.

Beside the bioremediation of water bodies, bio-enzymes are found to have several important applications in our daily life, such as, household cleaning. They can significantly minimize chemical hazards and detoxify pollutants and thus can replace many commercially popular harmful chemicals. On the other hand, preparation of bio-enzyme using fruit peels remarkably reduces and manages municipal solid wastes. We also report that the organic residue obtained from the fermented mixture after the separation of the bio-enzyme can effectively be used as a good quality bio-manure which can efficiently improve the soil quality by resisting the soil erosion, soil infertility, loss of minerals and increasing the organic matter in the soil. Thus we conclude that the preparation of Bio-enzyme from the citrus fruit peels can not only help to protect environmental degradation manage but also lead to an effective way to a pollution less food waste management.

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