"Bringing Lab to Our Home: Bio-Enzyme and its Multiutility in Everyday Life"

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Abstract: *Our main aim of this article is to review the production, functions, uses and challenges along with the future opportunities of bioenzymes in different sectors. Usage of bioenzymes instead of pesticides and disinfectant plays a major impact on the durability of soil and plants. In the times of a pandemic crisis such as COVID-19, which is spreading through symptomatic and asymptomatic carriers, it is essential to regularly disinfect all inanimate surfaces around us to contain community transmission. All household cleaning products contain toxic and aggressive chemicals, these cleaners are extremely hazardous to our health and the environmental implications of them are destructive. A greener way to disinfect does so is by creating a laboratory at home and synthesizing an environment friendly disinfectant. Usage of Bio enzymes can be termed as multi-faceted, as the process of synthesis is a completely natural process and can be easily carried out at home not only brings the feel of a chemistry laboratory at home but also is one step ahead in the direction of sustainable lifestyle.*

Keywords: COVID-19, community transmission, disinfection, bio-enzyme, sustainable lifestyle.

1. INTRODUCTION

Catalysis is the workhorse of chemical and energy industry. Energy efficient catalysts have tremendous potential to change the pace of a reaction in a desired direction. A catalyst is employed to increase the rate of a reaction. Addition of a poison may have an adverse effect on the activity of a catalyst. However, a catalyst will not 'poison' the rate of a reaction [1].When present in the same phase, they are termed as homogeneous catalyst and when present in different phase they are termed as heterogeneous catalyst. Enzymes are proteins that behave as biological catalysts and are used to control the rate of chemical reaction[1].It is one of the best alternatives to conventional chemical catalysts as they are biodegradable [2].

Bio-enzyme was first developed by Dr. Rosukon Poompanvong [3]. Bio-enzyme is also referred as Eco-enzyme, Garbage enzyme, Terrazyme etc., [4, 5]. Bio-enzyme works similar to enzyme as they degrade a large amount of waste within a small span of time [3]. Synthetically, bio-enzymes are a mixture of composite substances like proteins, salt etc. which are products of naturally occurring bacteria or yeast which are used to make bio-enzyme [6]. The combination of jaggery/brown sugar/molasses, citrus fruits, vegetable peels and water is involved in the fermentation process [4].

Fermentation can be described to be a chemical change which is brought about by employing microorganisms. An example of such a chemical transformation using microorganisms is pharmaceutical production, animal feed stuff, food additives etc., [7]. On the contrary, it can also be carried out under aerobic conditions (in the presence of oxygen)[2]. Molasses assist in fermentation process as it acts as a complexing agent and also as a carbon source for unaffected treatment of organochlorides [2]. Throughout the fermentation process, non-pathogenic i.e., a good bacterium breaks down larger pieces (organic waste, soil) into smaller particles [8]. It also generates products such as ozone, nitrates and carbonates etc., [4]. Ozone gas reduces the amount of carbon dioxide in the atmosphere and heavy metals that confines heat in clouds thereby lowering emission of greenhouse gases and hence helps in the reduction of global warming. Nitrate is an instinctive nutritious hormone for plants and carbonate has proven to be beneficial for aquatic life.

We dwell in a consumerist society wherein, most of the products are accessible with the click, but a closer look at their constituents and process of manufacture will reveal how injurious they are to the surroundings [9]. Contaminated surrounding contribute obnoxiously to the 3Ds of destruction of sustainable lifestyle i.e., disease, disturbance and distress [6]. The diversity of flora and fauna on planet earth is destructively affected when we stream chemicals into the environment, we are slowly destroying off their habitat [9]. This will eventually result in their extinction of many species in the long run.

In the times of a pandemic crisis such as COVID-19, which is spreading through symptomatic and asymptomatic carriers, it is essential to regularly disinfect all inanimate surfaces around us to contain community transmission. All home cleaning products contain toxic and aggressive chemicals, these cleaners are extremely hazardous to our health and the environmental implications of them are destructive. The use of these chemical products may resolve our household

difficulties quickly with ease and but it causes a grave problem for our nature. On the other hand, use of bio-enzymes, resolves many such problems associated with hazardous chemicals [9]. Natural enzyme is a multifunctional instinctive cleaner which unusually decontaminates the environment [7]. It is used as a fertilizer, herbicide, as a household cleaner and also for de-clogging the sewers [7]. Thus, employing kitchen waste to generate bio-enzyme saves money and our surroundings to a great extent [4].

Resorting to greener ways to do so is by creating a laboratory at home and synthesizing an environment friendly bioenzymes. As direct or indirect consumers of the numerous resources offered by Mother Nature, it should be our moral responsibility to alter the consumerist society to look at alternative options which are affordable too [10].

2. USES OF BIO-ENZYME

2.1 AGRICULTURAL USES OF BIO-ENZYME

India is primarily an agricultural nation. India's economic growth mainly depends on agriculture as it is a major source of employment and Gross domestic product (GDP) of our population. So, it is necessary for a country like India that ever flourishing agriculture is ensured. But in the recent times, many geographical locations are often face problems in production due to climate change, lack of rainfall and soil lacking in nutrients. And as a quick solution to all such problems, farmers often use chemical fertilizers, pesticides and insecticides like DDT hoping for a better outcome. Even though these chemicals show fruitful results initially but in the long run they drain the soil nutrients by killing the helpful microorganisms and make the soil even more infertile. Also, toxic pesticides and insecticides mix with the ground water and contaminate it during irrigation.

An easy, yet convenient way of avoiding all such problems is by using natural fertilizers like bio-enzyme to improve soil quality. Treating soil with bio-enzymes will make it more fertile and promote healthy growth of plants and also can keep pests infections at bay.

The following points mentioned below are the agricultural uses of bio-enzyme:-

2.1.1 Bio-Enzyme as Natural Fertilizer:

Chemical fertilizers are often used to enhance fertility of soil and to improve growth of plants. Most of these fertilizers contain three basic plant nutrients namely Nitrogen, Phosphorus and Potassium. Inorganic fertilizer had shown various serious adverse effects on farm soil such as: soil erosion, soil infertility, contamination of groundwater (leaching), soil friability, mineral depletion, loss of vital nutrients, decreased nutrients absorption, destruction of microorganism etc., [11], Inorganic fertilizers having high concentration of nitrogen lowers the pH of soil, thus, making top soil highly acidic [12]. Due to increased acidity in soil, a significant loss in crop production is observed. These problems can be easily resolved using natural fertilizer like bio-Enzyme, which are completely organic and serve as a completely natural alternative.

(a.) Barren land to fertile farm: Bio-enzyme is a boon for barren land. Bio-Enzyme revives barren land into fertile farm, by converting ammonia in the soil to nitrate. Thus, making land favorable for farming [4]. **Fig - 1** below shows how the application of bio-enzyme can increase soil fertility.

Fig - 1: Using bio-enzyme for about 3 months can turn a barren field into a fertile farm [4].

- In Malaysia, an uncultivated barren land was converted into a fertile land on treatment with eco-enzyme (**Fig - 1**).

Fig - 2: Conversion of barren land into fertile soil by application of bio-enzyme [4]

(b.) Purification of contaminated ground water: Enzyme residue used as natural fertilizer flows into land, hence purify contaminated water and avoid further leaching [4]. Diluted bio-enzyme also acts as liquid nutrient for soil and being completely organic it is also highly beneficial for the soil.

- At Tampines, Singapore, diluted Garbage Enzyme (1:1000) was sprayed once a week on leaves and soil which results in better nutrient absorption in soil and leaves [15].

Thus, it can be concluded that bio-enzyme being all natural and organic can be used efficiently as natural fertilizer to deal with disadvantages of chemical fertilizer.

2.1.2 Bio-Enzyme as Natural pesticide, insecticide and herbicide:

Eco-enzyme can be used as a natural pest repellent. Diluted eco-enzyme with water drive away disease causing microbes, viruses, insects, mosquitoes, flies, rats, cockroaches etc. from farm land .It also helps in controlling infection in plants and can be used for watering the plants[16]. Using concentrated bio-enzyme on crops also effectively kills weeds [17]. Thus, making bio-enzyme a favourable option for plantation and farming [4]. This is depicted in **Fig - 3**.

Fig - 3: Using bio-enzyme as a natural pesticide and insecticide [4].

- Farmers applied garbage enzyme on fields in Fazilka district of Punjab. This activity was carried out by Sri Sri Institute of Agricultural Sciences and Technology Trust (SSIAST), India Garbage Enzyme was applied on Guava tree, it was observed that the plant growth & size increased within twenty days of application and insects were successfully removed [16].

- Sri R. Dhawan of SSIAST, INDIA used bio-enzyme on paddy fields and studied its impact on the crops. It was observed that there was reduction of pests attack on the crops [16].

Thus, it can be concluded that eco-enzyme effectively manages plants pest like white flies, bugs, spider mites and aphids [14].Bio-Enzyme can be efficiently used as natural insecticide and herbicide.

2.1.3 Overall nourishment for vegetables and fruits:

(a.) First rate vegetables and fruits: Using eco-enzyme as a natural soil amendment enhances the photosynthesis, nutrients and water uptake in plants. Enhancing photosynthesis results in more nutrition uptake by plants. There will be more absorption of air by the roots and this will improve the quality as well as quantity of fruits and vegetables produced [4]. **Fig - 4** shows the fruitful outcome of using bio-enzyme for growing fruits and vegetables.

Fig - 4: Using eco-enzyme on plants results in growth of greener and healthier plants [4].

- In India, Purushottam Wayal, Marathwada Youth Leadership Training Program (YLTP) Coordinator of SSIAST used garbage enzyme on his field, and got a successful result as there was a huge increase in his production as shown in **Fig - 5** [16].

Fig - 5: Increase in crop production after application bio-enzyme [16]

- **Case study:** Farmers of Yamuna Nagar, Haryana used the Garbage Enzyme on maize and wheat crops provided by SSIAST. Observed that the production and seed germination have increased by twice in large amount. The garbage enzyme was also applied on yellow colored cattle feed and they all turned green in color with additional benefit of increased output. This is shown as before and after effect in **Fig-6** and analysis report of some crops in tabulated in **Table 1**.

Fig - 6: Turning yellow cattle feed to green by the use of bio-enzyme [16]

Table 1: Following are analysis of reports of two wheat crops with and without bio-enzyme [16]

Sample ID	**Wheat production without Enzyme**	**Wheat production With enzyme sprays**
Moisture%	9.49	9.77
Protein%	12.74	13.26
Starch%	65.55	66.22
Gluten%	10.43	10.31

- Mahadev Gomare of SSIAST had used Garbage Enzyme on his field and got mass production with good quality of crops.

Fig - 7: Increased production and quality using bio-enzyme [16]

(b.) Reduce period of cultivation: Ozone released by eco-enzyme helps plants grow faster and better [4]. This reduces the period of cultivation of crops as is shown in **Fig - 8**.

Fig - 8: Usage of Bio-Enzyme in farms reduces period of cultivation [18]

(c.) Plant growth promoter: Usage of dried leftovers residue as a soil amendments in the soil, enriches the soil with earthworms (farmer's friend). Earthworms promote natural and healthy growing of vegetables and fruits [14]. Bio-enzyme also acts as natural hormone which cultivates plants naturally. Bio-enzyme granules also help in the uniform growth of crops, and makes crops strong to withstand stress and drought conditions. It also reduces premature dropping of flower and fruits (Enzyme Liquid - [18]. **Table 2** shows different dilutions of eco-enzyme with water for different purposes.

- R. Dhawan in his initiative had tested the application of Garbage Enzyme on potato and cauliflower along with farmers of Yamuna Nagar, Haryana. In potato crop, production was increased by 10 quintals per acre than the previous year. The plants were also of bigger size, white and resisted pests. Cauliflower plantations also shown similar results [16].

Table 2: Following table showing various concentrations of eco-enzyme with water for different purposes.

Enzyme for Fertiliser	1: 100/500/1000
Enzyme for Insecticide	1: 1000
Enzyme for Pesticide	1: 100
As plant Growth Hormone	Dilute 500x

2.1.4 Benevolence to livestock

- Eco-enzyme being loaded with anti-viral and anti-bacterial properties can be used to sanitize areas properly for livestock and makes it germ-free. **Fig - 9** depicts the advantages of using eco-enzyme for the livestock.

(a.) Cleanliness maintainer- Spraying eco-enzyme on floor of shed keeps flies and foul odour away resulting in germ-free, hygienic place for domestic animals to live. Eco-enzyme can also be used as air freshener.

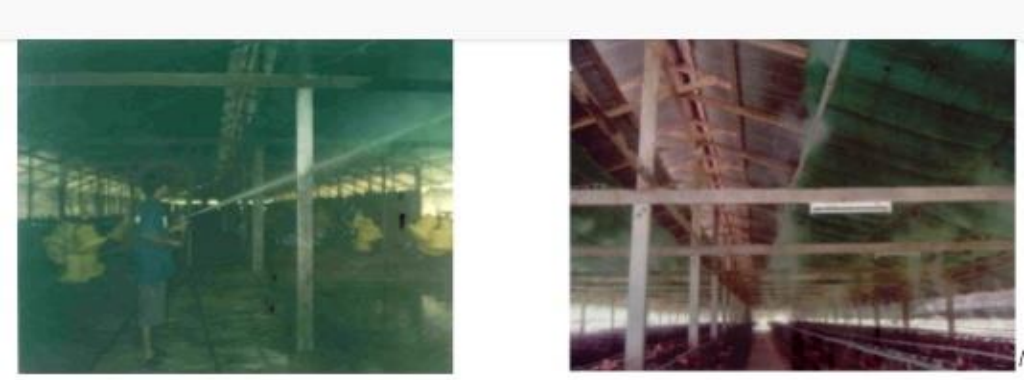

Fig - 9: Application of Eco-Enzyme for maintaining hygienic conditions in cattle sheds [4]

(b.) Natural animal health booster- Addition of bio-enzyme to food like grass and hay meant for feeding domestic animals increases their immunity to most diseases and keeps them healthy as depicted in **Fig - 10** and **11** respectively.

Fig - 10: Bio-enzyme is mixed with fodders keeps domestic animals healthy and immune [4]

Fig - 11: Eco-enzyme mixed with water for cattle [16]

- In Thailand, a pig farm owner uses only eco-enzyme, with the goal of keeping his pigs healthy. Rejection of drugs or additives has shown improvement in health of pigs in his farm as shown in **Fig - 12**.

Fig -12: Application of Bio-enzyme for maintenance of good health in pigs [4]

(c.) Increased poultry products: Improvement in the health of animal favours the farmer with high quality of animal products. There would be increase in both quality and quantity of milk, poultry, and meat products [4].

2.2 Bonus Benefits of Eco-enzyme /bio-enzyme:

- **Fresh Air**: Application of bio-enzyme also keeps air in farm clean, fresh and cool [4].

- **Cost Reduction**: Various application of eco-enzyme as nature friendly pesticides, fertilizers, decontaminating ground water agent, growth and quality booster for fruits and vegetables resulting in higher yield, taste and quantity. Serving as a natural health supplement for livestock. All these applications cut out on money expenditures, hence making bio-enzyme cost effective.

- **Helps in Nitrogen fixation**: Eco-enzyme also fixes Nitrogen in soil and helps in the growth of nitrogen-fixing bacteria which helps in proper growth of plants.

- **Compos**t: Residue of eco-enzyme can be used in compost pit as manure [5].

- **Beneficial for aquatic plants**: Diluted eco-enzyme helps in growing of aquatic plants like duck weed etc. It also helps in keeping lake, ponds clean and free from microbes, hence, fish, fisheries and other aquatic animals healthy and germ free[16]. Such a use is depicted in **Fig - 13**.

Fig - 13: Bio-enzyme use for cleaning Ponds and lakes[2].

2.2.1 Some Other Significant Uses of Bio-Enzymes:

1. Antimicrobial activity of bio-enzyme:-

Fruits and vegetables get easily decomposed and this causes problem in their disposal into landfills [20]. This problem however can be solved very easily by fermenting waste fruits and vegetables into garbage enzyme which is a multipurpose ecological cleaner. Bio-enzymes are enriched with various anti-bacterial and anti-viral properties.

- **Case Study:**

A study was conducted in Nepal in 2018 to analyse the enzymatic and anti-microbial efficiency of garbage enzyme produced from different fruits and vegetables [20]. Total 6 samples including 5 fruits peels sample i.e. Lime, Pineapple, Pomegranate, Papaya and mixed fruit and one vegetable peel were taken for this study [20]. **Fig- 16** shows the anti-microbial efficiency test of bio-enzyme performed in a laboratory in a bacterial species.

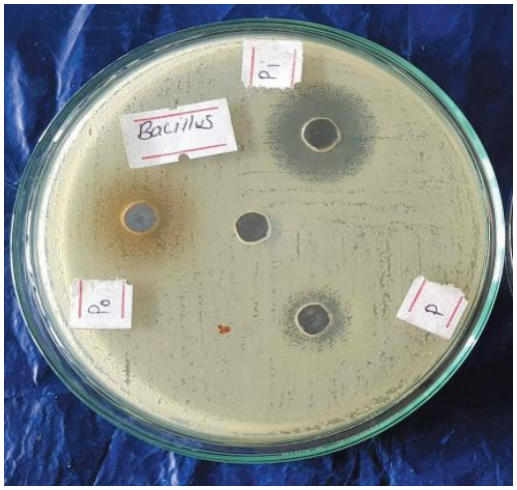

Fig - 16: Anti-microbial efficiency test of garbage enzyme in *bacillus* species.

[Pi= Pineapple, P=Papaya, Po=Pomegranate, C=Control] [20]

Table 3 and **4** depict the anti-microbial activity of bio-enzyme prepared from various starting material such as Mosambi, Pomegranate, Pineapple, Papaya and mixed fruits and vegetables on gram positive and gram negative bacterial species.

Table 3: Antimicrobial activity of garbage enzyme on Gram positive bacteria [20]

Name of the sample	Zone of inhibition (mm) on Gram positive bacteria		
	S. aureus	*S. aureus* (ATCC 25923)	*Bacillus* spp
Mosambi *(Citrus limetta)*	16	16	18
Pomegranate *(Punica granatum)*	30	25	18
Pineapple *(Ananas comosus)*	23	24	22
Papaya *(Carica papaya)*	18	0	13
Mixed Fruits	12	14	16
Vegetables	0	19	0

Table 4: Antimicrobial activity of garbage enzyme on Gram negative bacteria [20].

Name of the sample	Zone of inhibition (mm) on Gram negative bacteria				
	Shigella spp	*Pseudomonas aeruginosa*	*Salmonella Typhi*	*E. coli*	*E. coli* (ATCC 25922)
Mosambi *(Citrus limetta)*	20	17	20	18	24
Pomegranate *(Punica granatum)*	19	13	18	24	21
Pineapple *(Ananas comosus)*	28	25	20	18	27
Papaya *(Carica papaya)*	17	21	15	14	14
Mixed Fruits	20	18	0	17	19
Vegetables	0	0	0	0	23

From the study, it was concluded that garbage enzyme prepared from different fruits and vegetables showed anti-microbial activity with gram-positive and gram-negative bacteria. So from here it can be concluded that garbage enzyme can be utilized for multiple cleaning purposes as it can kill/inhabit various pathogens [20].

2. Influence of bio-enzyme on Palm Oil Mill Effluent:-

Milling activities of palm oil crop often produces highly polluted wastewater which is known as palm oil milling effluent. It has high contents of polluting substance and thus requires effective treatment before being discharged into main water bodies [21].

Palm oil is one of the world's most rapidly expanding equatorial crops [21]. When POME (Palm Oil Mill Effluent) is discarded directly into the environment without pre-treatment it may cause excessive pollution of soil and water resources. So it is extremely necessary that low cost pre-treatment of POME (Palm Oil Mill Effluent) is carried out using garbage enzyme before disposal to ensure safety of our environment.

- **Case Study:**

A study was conducted in Malaysia to analyse the effects of treating POME (Palm Oil Mill Effluent) with bio-enzyme. POME (Palm Oil Mill Effluent) samples were analysed in context to oil and grease (O&G) content, total suspended solids (TSS) and chemical oxygen demand (COD) [20].

The **Chart** data of the above study are as shown below in **Chart- 1, 2, 3** and **4** respectively.

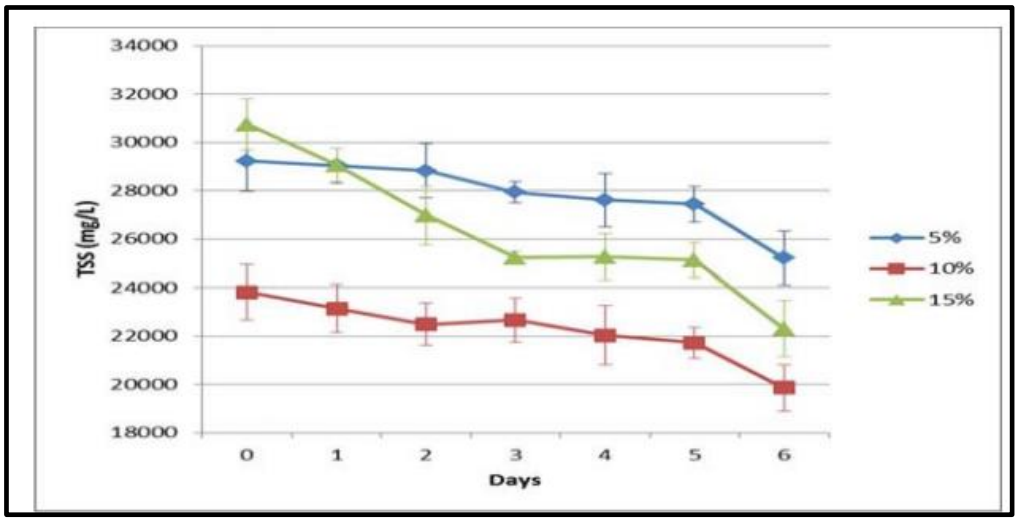

Chart - 1: Effect of different dilutions of bio-enzyme to POME (Palm Oil Mill Effluent) on TSS [21].

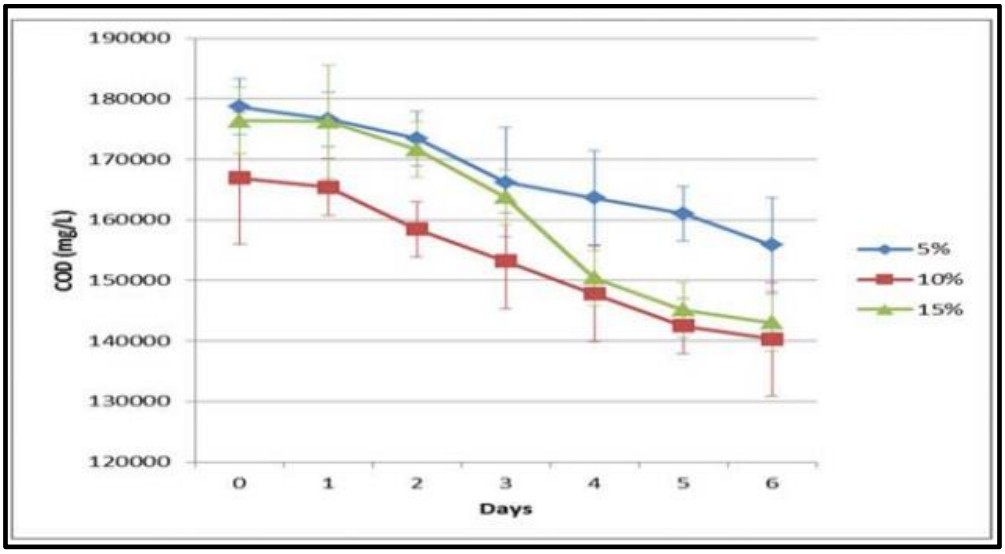

Chart - 2: Effect of different dilutions of bio-enzyme to POME (Palm Oil Mill Effluent) on COD [21].

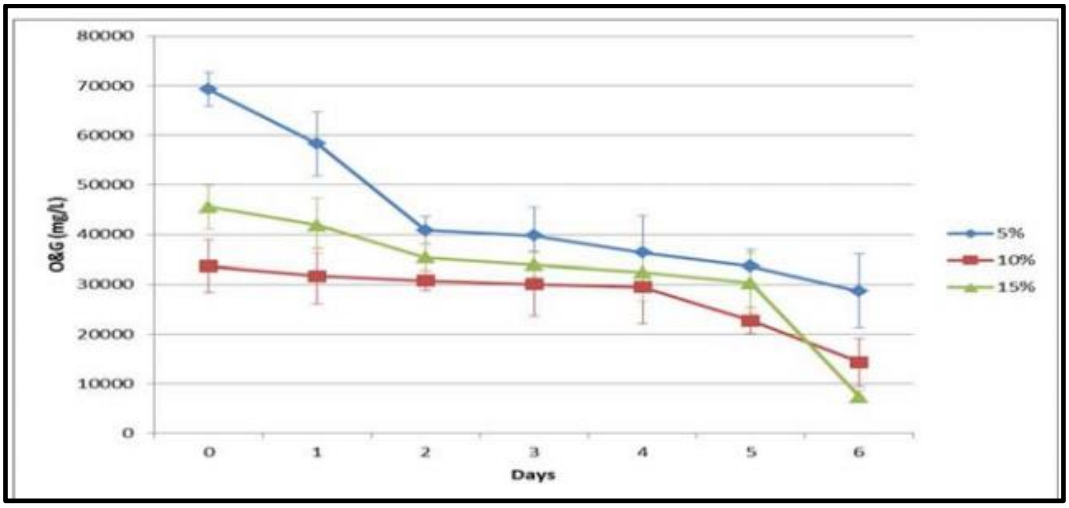

Chart - 3: Effect of different dilutions of bio-enzyme to POME (Palm Oil Mill Effluent) on O&G ([21] *et al.*, 2018)

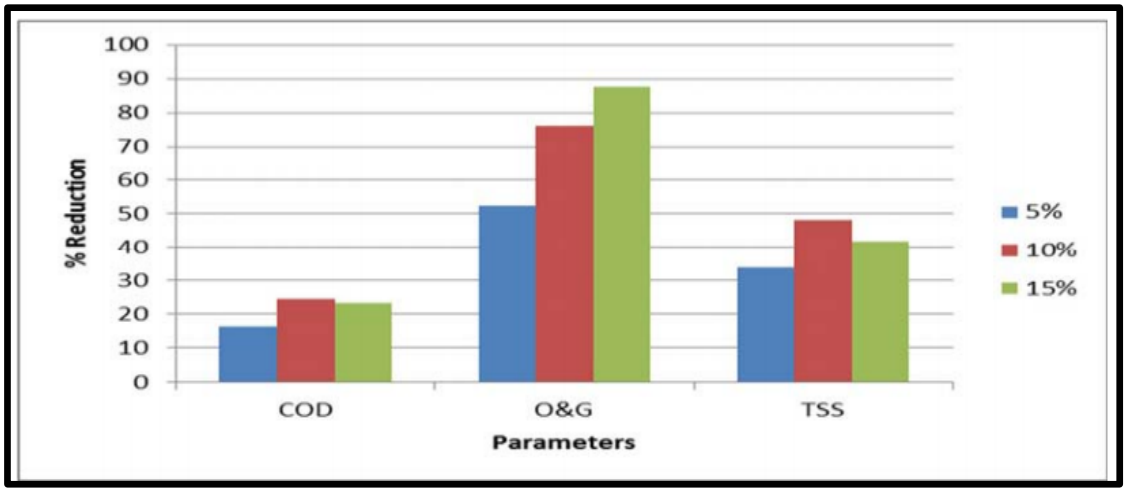

Chart - 4: Percentage of reduction of various parameters at different levels of dilution of garbage enzyme to POME (Palm Oil Mill Effluent) [21].

This study showed that garbage enzyme or eco enzyme prepared from waste fruits and vegetables by fermentation process contained bio-catalytic enzymes. When POME (Palm Oil Mill Effluent) was pre-treated using 15% dilution of garbage enzyme there was removal of 90% O&G content. It was noted that there was a reduction of about 50% TSS and 25% COD content when 10% diluted garbage enzyme was used [21].

2.3 Non-agricultural Uses of Bio-Enzyme

Nowadays, the chemical cleansers available in the market are loaded with increased amounts of chemicals which are very harmful for our environment and the in ways more than one. It is now becoming evidently more mandatory to shift our focus from these harmful chemical products to natural alternatives. Multiutility in a bioalternative solution shall set the trend for attracting users far and wide. Bio-enzymes or garbage enzyme or eco-enzyme are obtained by fermentation process of organic waste using mixture of jaggery, citrus, and water in the combination ratio of 1:3:10. It can be conveniently prepared from the comfort of our home. In tough times, such as the COVID-19 pandemic that the world is going through, this is an endeavor to bring the laboratory to our own homes. Bio-enzymes are completely natural and using this in our everyday life, we can ensure safety for all flora and fauna belonging to Mother Nature.

The following are the non-agricultural uses of bio-enzyme:-

1. Air Purification:

Bio-enzymes help in odour removal with no use of chemicals. It helps killing disease causing germs which often produces dampness and foul odour. So bio-enzymes act as natural air purifier [13]. Diluting and spraying bio-enzyme in our home will provide a sense of freshness and keep pollutants at bay.

2. Household cleaning:

Nowadays, in order to save time we often end up buying chemical cleansers stocked up in the supermarket shelves thinking those to be very effective but we fail to realize how these cleansers are loaded with toxic chemicals like phosphates, ammonia, chlorine etc. and can also cause several harmful impacts to our health and environment in the long run. We don't realize that we may be allergic to many of those chemical contents which may cause eye-irritation, allergy, skin rashes etc. These products are also a major source of environmental pollution and we are contributing to environmental pollution and degradation daily without even understanding its harmful impact. On the other hand, we can shift our focus to bio-enzymes which are completely chemical-free and indeed a best alternative for our household cleaning needs i.e., to clean household areas including kitchen, toilet etc., [4, 13].

Using an appropriately diluted bio-enzyme solution removes disease causing bacteria in daily household cleaning. It acts as an insect, cockroach and a mosquito repellent [13]. Bio-enzymes can be used to clean bathroom fittings as it removes lime scale deposition. It can be used as surface cleaner, floor cleaner, stain removal etc., [4]. All these benefits with zero harm to the environment. The various household applications of bio-enzyme are as shown in **fig- 14**.

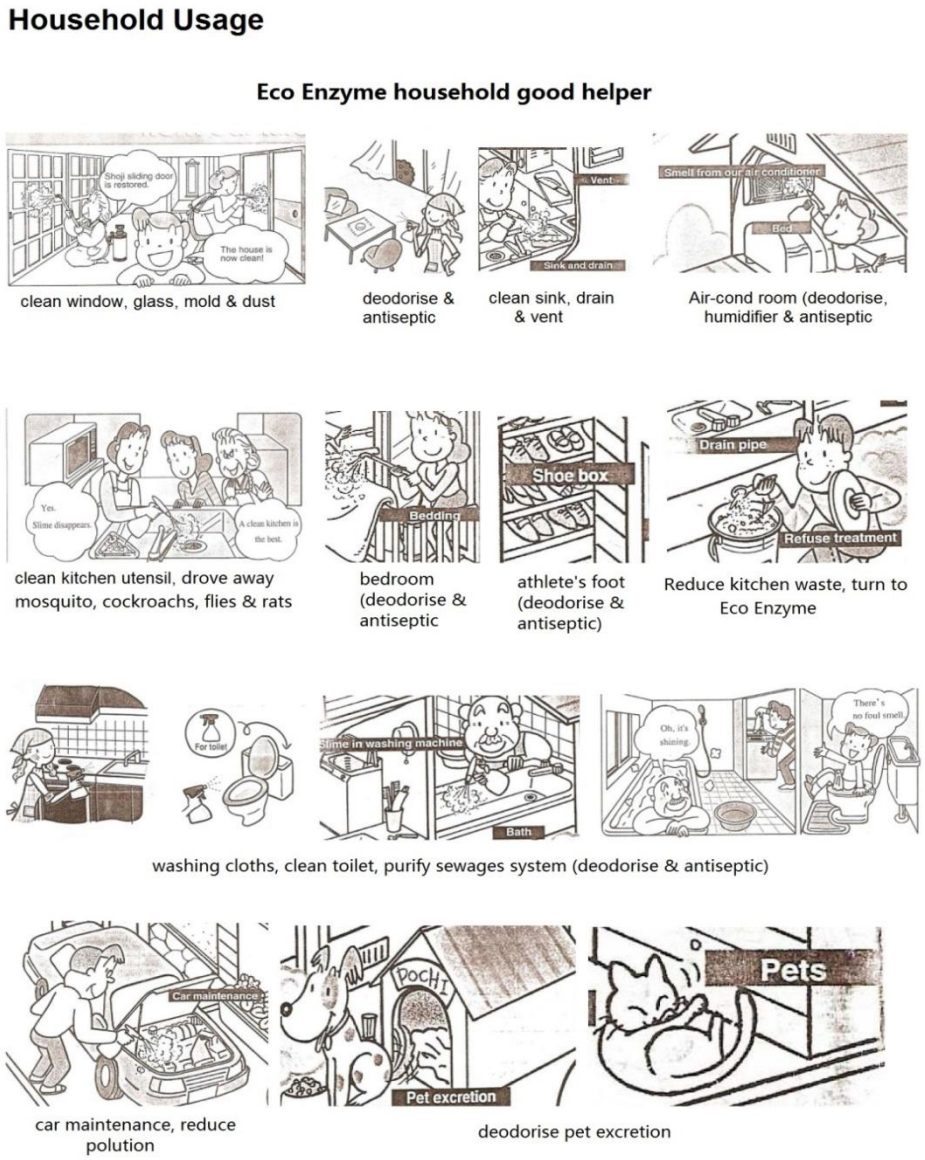

Fig -14: Various household uses of bio-enzyme [4].

3. Reduce Carbon dioxide levels:

Due to ever increasing Carbon dioxide levels in our atmosphere there is an increased greenhouse effect and global warming. Climate change is an issue that needs to be addressed without any further delay. The use of eco-enzyme has shown promising results for overcoming this problem because it releases ozone (O_3) and can reduce carbon dioxide levels in atmosphere and heavy metals like Cd that traps heat in the clouds. So bio-enzymes help in reducing global warming and purifies air from pollutants [4].

4. De-clogging of drains:

Our drainage and sewage systems are often clogged with solid wastes, disposed off directly from household and also from factories. This causes the problem of water logging and flash floods.
Bio-enzyme helps in de-clogging of drains, by pouring bio-enzyme directly through pipes. The microorganisms present help in efficient de-clogging [4].

5. Personal care products:

Bio-enzymes are loaded with various anti-bacterial and anti-fungal properties. Bio-enzymes prepared from aloe vera can be usually used in skin care and hair care products like moisturizers, shampoo, conditioner, face masks [22]. But skin patch test should be done before using to check if we are allergic or not to the product.

6. Laundry:

Synthetic detergent contain chemicals and causes the problem of excess foam production in lake and river which in turn causes water pollution and reduces the amount of dissolved oxygen available for aquatic plants and animals. This can be prevented by using eco-enzyme along with soapnuts which will be completely natural detergent having excellent cleansing properties. It efficiently removes dirt and grease from dirty clothes [4, 13]. It also keeps the fabric quality good for a longer amount of time.

7. Construction of roads and improving soil quality:

Bio-enzymes under different names like Renolith, Permazyme and Terrazyme have been used for construction uses under different experimental studies in India. And this has led to cost reduction [23]. Through studies it is found that Renolith improves soil strength and Permazyme acts as a compaction enzyme, it causes the compaction of clay and slit at a faster rate. Terrazyme is found to have high strength and resistance towards deformation. It increases load carrying capacity of soil [23, 24].

- Renolith technology has been used for some projects by the **Public Works Department** (PWD) of Arunachal Pradesh and Rajasthan [23].
- Terrazyme has been used in road construction project in Nasik, Maharashtra. Also trial studies were carried out in states of Tamil Nadu, Kerala and Karnataka [23].

8. Solid Waste Minimization:

In the recent times managing the disposal of municipal solid waste (MSW) has become a major issue especially in developing countries due to growing economy and ever increasing population. This is a major problem typically in the urban areas. And these solid waste generated ends up in landfills causing environmental pollution in the long run. Physical and chemical interactions along with moisture and humidity in the air lead to the generation of landfill leachate [25], which is a mixture of various pollutants, organic and inorganic compounds, natural and artificial substances, toxic and heavy metals etc.,

Thus, it has become very important to look for an alternative greener solution for the disposal of MSW. One way for achieving this is using eco-enzyme for the reduction of waste generated. We can achieve this by following Dr. Rosukon's method of converting organic waste to useful garbage enzyme, which will largely help in the reduction of MSW as most of the solid waste disposed in landfills consists of organic matter [26].

- **Case Study 1**: A recent study was conducted in Malaysia to see the effects of eco-enzyme in reduction of municipal solid waste generated and their disposal in landfills. It was observed that as more and more people recycled their organic waste using garbage enzyme there was a significant reduction in the amount of MSW deposited in a landfill as shown in **Chart -5** [26].

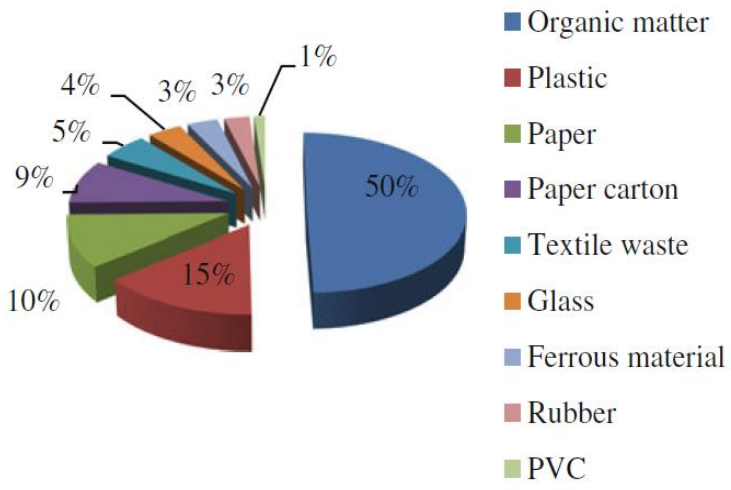

Chart -5: showing the composition of MSW in Malaysia, 2009 [26]

- **Case Study 2:** A study was conducted in India in the landfill sites of Ghazipur, Okhla and Bhalswa to see the effect of using garbage enzyme on landfill leachate pollution index (LPI) values [25]. It was observed that after 28 days, there was about 55-74% reduction in LPI values with a 5% mixing ratio of garbage enzyme for Ghazipur and Bhalswa landfill and with a 20% mixing ratio for Okhla landfill respectively.

3. CONCLUSION

In this review, we have tried to highlight the function of bioenzyme based on plant waste. We tried to explore various aspects of bioenzymes. It mainly plays a role in plant growth and vegetation as well as disinfectant, etc. Human beings have knowingly and unknowingly employed enzymes extensively for an array of purposes from dairy industry to life saving therapeutic agents. Bio enzymes are a promising category of chemical agents produced by bacterial action which are multipurpose depending upon the starting ingredient that one employs. They have been further employed for improving the plant durability at low cost and being applicable relatively. There is accessibility of several commercial enzymes in the market, owing to their easy production processes. But what intrigues us is the production of these bio enzymes at low cost, being easy to use and environmental friendly bioenzyme preparations from the locally available, raw material can be a topic of further study for researchers and educational institutes.

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