

Bioenzyme Production from Waste as Organic Fertilizer

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Abstract

Bio-enzyme is an organic liquid compost that can be used as an organic fertilizer. The waste generated from fruits and vegetables can cause pollution of the air, water, and soil, but being organic, this waste can be significantly utilized in bio enzyme preparation. A bioenzyme can be prepared by two methods: the fermentation method and the extraction method. By fermentation method, it can be prepared by using fresh fruit peels, vegetable waste, jaggery and water. The fermentation of waste is carried out by the bacteria in anaerobic conditions. They can also be prepared by making extracts of other organic wastes and mixing them with sticky agents, viz., refined oil and soap. Besides agricultural purposes, these can also be used for several purposes, like disinfecting tabletops, removing stains from dishes, cleaning floor tiles, and as room fresheners due to their characteristic fragrances. It helps in reducing the waste and turning it into a useful substance organic fertilizer. Bio-enzyme can be utilized as a cleaning agent as well as an excellent fertilizer. Here the work has been undertaken by undergraduate students to prepare bio-enzymes from vegetable wastes and fruit peels available at home by anaerobic fermentation in the lab. This can also be carried out at the commercial level on a large scale and can improve the economic status of the farmer.

Keywords

Chemical fertilizers, Crop production, Bio enzymes, Anaerobic fermentation and Commercial use

Introduction:

In urban areas usually solid waste ends up in landfills, polluting the environment. This waste is composed of organic and inorganic molecules, natural and manufactured substances, poisonous and heavy metals, etc. As the population is increasing, waste generated from community activities is also increasing at an alarming rate. In our country large amount of fruit peel waste and waste from household kitchens has been generated. Firstly, Fruits and vegetable-derived organic waste is typically dumped in landfills, which not only causes waste-related issues but also degrades the environment. The second issue is that in Agriculture we are becoming more dependent on inorganic chemicals for using them as fertilizers. It has been observed that by using excessive chemicals the diversity of flora and fauna is adversely affected and destroying off the habitat (T. Patel, 2020). This will lead into the extinction of many species, further deteriorating the ecosystem. In present scenario it has become very important to adopt some alternative sustainable solution for the disposal of the waste and at the same time utilisation of organic waste into useful byproduct. For sustainable solution conversion of organic waste into eco-enzyme can be the best way. This can be achieved by following Dr. Rosukon's method of converting organic waste to useful garbage enzyme, as most of the solid waste disposed in landfills consists of organic matter (Y. Ming, 2014).

Fruit and vegetable peel wastes are highly rich in bioactive compounds. We can utilize these kitchen wastes and horticulture waste in sustainable way for the production of value-added products bio enzymes. Multiple enzymes such as amylase, protease, cellulase and lipase are found in these bio enzyme solution (Panicker et al., 2021). This process of producing enzymes such as protease, lipase and amylase produced by the fermentation method using microorganisms can be an alternative to synthetic cleaning solutions. These bio-enzymes are known by different names, such as Eco-enzyme, Garbage enzyme, Terrazyme, Fruit enzyme, Flower enzyme etc. (Khadka and Neupane, 2019). Ecoenzyme/bioenzyme is a complex organic solution produced from the fermentation of fruits and vegetable waste. In general these are a mixture of enzymes which catalyze large amounts of reactions within a short span of time (Sethi et al., 2021). Garbage enzyme can be produced by utilizing fruit and vegetable wastes such as pineapple, mango, orange and tomato which undergo a fermentation process. Fermentation process is completed within 90 days. Fermented liquid is dark coloured and have strong aroma. The bioenzyme can also be used in household purposes. It can be used as a cleaning agent to remove the impurities on the floor and furniture surfaces because of its acidic condition. It can equalize the pollutants especially toxins in the atmosphere, water bodies or land. Therefore, it can be used for air purification or deodorizer in order to remove odor and dissolved toxic air. Due to its acidic nature bioenzyme can destroy the harmful microorganisms, so it can be

used as an insecticide or pesticide. Furthermore, bioenzyme can also be used as a natural organic fertilizer. These enzymes improve the soil fertility and directly increase the crop yields without any pollution. It not only provides the solution to reduce the fruit and vegetable waste on landfills, but also helps in the process of recycling by utilizing the waste in a sustainable way.

Objective :

- To prepare bioenzyme in a sustainable way to reduce waste
- To know about its process and significance

Material and Method :

For this paper secondary information was taken from various research articles published in reputed journals. Then, an experiment has been carried out by undergraduate students in the Zoology lab to study the method of preparation of a bioenzyme by fermentation method from fruit peels which involves the preparation of bioenzyme using different substrates i.e. citrus fruit, ginger, garlic and chilli. It involves three steps: 1. Preparation of bioenzyme 2. Filtration of bioenzymes 3. Characterisation of bioenzymes. The materials used for the preparation of enzymes are Jaggery, Water, Container with a screw cap, Fruit peels, Vegetable peels and Yeast (*Saccharomyces cerevisiae*).

Discussion:

Bio-enzyme was first produced by Dr. Rosukon Poompanvong in Thailand (C. Arun and P. Siva Shanmugam, 2015). Bio-enzyme is also known as Eco-enzyme, Garbage enzyme or Terrazyme (P. Agarwal & S. Kaur, 2014). There are various experiments that have been carried out to study the production of bioenzymes from the organic waste of fruits and vegetables with different purposes. Kanchana, R., et al. carried out an experiment on “Production of Multi-Utility Bio-Enzyme.” from fruits and vegetable wastes and studied the method of preparation and qualitative analysis of secondary metabolites. In this study maximum and rapid growth was observed in seeds treated with the bio-enzyme solution. Study on Characteristics (like pH, aroma, TDS) of ecoenzyme formed by using different substrates has been carried out. In one of study bio-enzyme having effective anti-bacterial as well as anti-fungal properties has been observed so advocates the use of bioenzyme as cleaning agent (Harkeerat Singh and Aarti Prasad, 2019). In many researches when quantified these peels of various fruits like peels of pineapple (*Anana scomosus*), papaya (*Carica papaya*) and mixed fruits reported protease enzyme activity while Pomegranate peels (*Punica granatum*) showed lipase enzyme activity (Neupane and Khadka, 2019). In other research efficacy of bio-enzymes for various applications was studied (Naik, 2022).

Fermentation Process: We do not need a fermenter or particular equipment for their preparation and it can be prepared using any container with a lid or bottles at home and

kitchen gardens (Sethi et al., 2021). A bioenzyme or coenzyme is prepared by fermenting organic waste, sugar (jaggery, cane sugar, molasses) and water in a ratio of 3:1:10. The jaggery/brown sugar/molasses, fruits and vegetable peels mixed with water are utilized for the fermentation of bio-enzymes (Vama L. and Cherekar, 2020).

For the production of bioenzymes fermentation method was adopted. The peels from fruits and vegetables that have been consumed at home were gathered which includes the peels of citrus fruit for the first bioenzyme and the second one was prepared by using ginger, garlic, chilli as substrates. Collected material was further divided into smaller pieces so that the reaction's surface area would be increased (Fig:1,2,3).



Fig: 1. Ginger, garlic and chilli Fig: 2. Citrus fruit Fig: 3. Filtering of bioenzyme

For the fermentation of waste an air-tight container has been used, here the clean plastic bottles were used for the fermentation of waste, as the production is carried out at smaller scale. Now, the different ingredients were added in a definite ratio i.e., 1(jaggery): 3(substrate):10 (water).

For citrus bioenzyme: Almost 50gm of jaggery, about 150gm of citrus fruit waste and 500ml of water in a clean plastic bottle were mixed thoroughly.

For ginger, garlic and chili bioenzyme: About 50 gm jaggery was mixed in a clean plastic bottle with 50 gm each of ginger, garlic and chilli and 500 ml of water.

Some pinches of yeast powder (*Saccharomyces cerevisiae*) were added to accelerate the fermentation process. Little space was left while closing the lids of bottles so that gases can be released during the fermentation process. After closing the lid of plastic bottles, they were kept undisturbed in a safe, cool and dark place to avoid direct contact with sunlight for about 3 months to ferment. Gases were produced during the first month of the fermentation process and were required to be released. The gases were vented daily by opening the lid once a day to prevent the bottle from bursting due to the buildup of pressure. In the last two months of this process lesser number of gases were produced, which were released by opening the lid once or twice in a week.

After three months by the process of filtration was carried out (Fig. 3). The solution was filtered with a sieve or fine cloth and the concentrated liquid was separated from the residues, thereafter filtrate was saved for later use. Residues obtained during filtration can

be dried to use as fertilizer. Checked the colour of the solution in both the bottles which turned darker and both the solution had their specific characteristic odour .



Fig:4 filtered citrus bioenzyme



Fig :5 filtered bioenzyme of garlic, ginger & chilli

While checking characteristics of different bioenzymes it was observed that citrus bioenzyme had acidic and melodious fragrance while ginger, garlic and chilli bioenzyme with a sharp, pungent smell (Fig:4,5). All these activities are carried out in the zoology lab by the undergraduate students (Fig. 6, 7). Besides citrus, ginger, garlic and chilli there are many other organic wastes that can be used for bioenzyme preparation such as eucalyptus leaves, neem leaves, cinnamon, bay leaves, clove marigold flowers, bael leaves etc. (Fig:8,9,10,11).



Fig : 6,7 : Students with different types of bioenzymes prepared by using different substrates



Fig: 8 bay leaves



Fig : 9 clove



Fig:10. Neem leaves



Fig:11. Marigold flowers

Significance of Bioenzymes:

At present the most of the inorganic fertilizer have adverse effects on farm soil causing soil erosion, soil infertility, contamination of groundwater (leaching), mineral depletion, loss of vital nutrients, decreased nutrients absorption and destruction of microorganism (USEPA.,2020). These fertilizers contain a high concentration of nitrogen that lowers the pH of soil, and changes natural soil into highly acidic soil (J. Hunt, 2020). We can replace the inorganic fertilizers with organic fertilizers, i.e., Bioenzyme can be used in agriculture for sustainable utilization. Bio-enzyme enhances the photosynthesis, nutrients and water uptake in plants. These also help in the absorption of air by the roots and improve the quality as well as quantity of fruits and vegetables. Bio-enzyme extracts have the presence of secondary metabolite which are helpful for the growth of plants.

Eco-enzyme fixes Nitrogen in soil which keeps the growth of nitrogen-fixing bacteria and enhance growth of plants. Eco-enzyme residues are utilized in a compost pit as manure (Agarwal and Kaur, 2014). These can be used as soil stabilizers and can be useful in making compost.

Bioenzymes can be used by dissolving in water for killing microbes, viruses, insects, mosquitoes, flies, rats, cockroaches etc. It also helps in controlling infection in plants and can be used for watering the plants. Bio-enzyme acts as natural pest repellent, killing weeds.

Bio-enzymes improve the growth of aquatic plants like duck weed etc. and keep water bodies clean and destroy microbes making fish, fisheries and other aquatic animals healthy and germ-free.

Bioenzymes prepared from organic waste have their characteristic odour and huge importance and various applications. The bioenzyme of citrus due to its acidic properties and pleasant odour can be used as a cleaning agent and also as a deodorizer while the ginger, garlic and chilli bioenzyme due to its sharp, pungent smell can be used as an insecticide. Bio-enzymes are rich in various anti-bacterial and anti-viral properties.

Bio-enzyme microorganisms remove the clogging and help in de-clogging the drains. Bioenzymes turns organic waste to useful garbage enzyme, which reduce municipal

waste of landfills (Ming.etal.,2014). In waste water treatment bioenzymes can be economical solution (Kumar etal.,2020; Kerkar and Salvi, 2020).

Bio-enzyme solution can be used as cleaning agent and prove to be an excellent fertilizer for various crops. It purifies ground water and therefor we can use it as natural pesticide and herbicide (Panicker et. al.,2021; Galintinet al, 2021).

Plants like Aloe vera can be used for making bioenzyme which are used in skin care and hair care products like moisturizers, shampoo, conditioner, face mask (K. Kumar and Deshmukh, 2016).

Bio-enzyme helps in overcoming the air pollution problem of increased carbon dioxide level as it releases ozone (O₃) and can reduce carbon dioxide levels in atmosphere and heavy metals like Cd. Thus bio-enzymes purify air from pollutants and can contribute in minimizing global warming.

Conclusion:

The production of bioenzymes from organic waste represents a sustainable and eco-friendly approach to waste management and resource utilization. By converting biodegradable waste into valuable bioenzymes, this process reduces environmental pollution, landfill burden, and greenhouse gas emissions. It promotes the recycling of organic materials into useful products that can be applied in agriculture, wastewater treatment, household cleaning, and industrial processes. Additionally, bioenzyme production from organic waste is cost-effective, supports circular economy principles, and encourages community participation in sustainable practices. Overall, this approach not only addresses waste disposal challenges but also contributes to environmental conservation, economic benefits, and the development of green technologies. Overall, the study and application of bioenzymes contribute to improved agriculture, technological advancement, and environmental sustainability, making them indispensable to both living organisms and modern society. Bioenzyme have many other applications; they can be used in waste water treatment as they break down organic pollutants, and can be as fertilizer as it maintains the soil structure, fertility and stability. Bioenzymes are helpful for the growth of useful microorganisms in soil. As organic waste is utilized for the production of bioenzymes hence it also reduces the burden on landfills and plays role in sustainable waste management. Bioenzyme production can also be carried out at commercial level which will not only reduce the amount of waste in environment but also help in improving economy of the agriculture sector.

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