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Production of Potential Bio-Compost from Household and Market Waste Vegetables for the Improvement of Plant Growth

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ABSTRACT

Production of crops using fertilizers plays an important role in agriculture. But the tremendous application of chemical fertilizers has a great influence on human health as well as the environment, hence nature demands the application of environment-friendly fertilizers. The main objective of the present study was to formulate the production of bio compost utilizing waste and non-edible vegetables along with spoiled fruits collected from Shahada market and household regions. The compost produced with waste vegetables and fruits was enriched with Azotobacter and Rhizobium inoculant along with sugar industry distillery effluent and cow dung. The resulting enriched bio compost was applied for the growth of wheat, mung and groundnut seeds by pot assay technique. Results obtained revealed that as compared to control seeds, a tremendous increase in the root and shoot length, plant height, chlorophyll content, and percentage germination was found in seeds treated with bio compost as compared to chemical fertilizer and control. The present study concluded that vegetable waste with microbial fertilizers and distillery effluent along the cow dung was found to be potential fertilizer for the growth of plants and environmental sustainability.

Keywords: *Waste vegetables, Azotobacter, Rhizobium, Distillery effluent, Bio-compost*

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INTRODUCTION

Continuous rise in population demands an increase in food but industrialization and developments limit the availability of land for crops cultivation which created a major issue nowadays. However, to fulfill the crucial demand for food, the use of chemical fertilizers and pesticides has been extensively increased to upsurge the yield and growth of food production crops. An improvement in the growth of plants and nutrient uptake is seen with the applications of fertilizer (Chew *et al.,* 2019). But when used continuously chemical fertilizers cause the soil to lose fertility and adversely affects soil and crop quality are also adversely affected (Indumati, 2017).

Biofertilizers are the formulations combined with efficient strains of microorganisms or living cells that through their interactions in the rhizosphere help the crops uptake of nutrients when applied through soil or seed (Lim & Matu, 2015; Sumathy & Devi, 2017). Microbes in the biofertilizers form the association with roots or the inner part of the plant and stimulate the growth of the host plant by providing essential nutrients, phosphorus, nitrogen and potassium (Sudhakar & Ranganathan, 2020; Mahmud & Chong 2021; Chaudhari, 2022). Biofertilizer production by composting is generally a method frequently used to recycle various organic byproducts into fertilizers that are useful for the soil. The biological oxidative decomposition process where by complex degradable components are decayed and altered by microorganisms into by-products organic and inorganic is known as composting (Toledo *et al*., 2018; Diacono *et al.*, 2019; Ayilara *et al*., 2020). Multiple degradable wastes can be transformed into safe and beneficial products employed as soil amendments and biofertilizers (Yu *et al*., 2019; Asadu *et al*., 2020). The advancement of high-impact micro-organisms within the compost change over biodegradable natural matter into a lasting item for storage and application without unfavorable ecological effects. Different substrates may be included in the waste amid the composting handle. They are either natural (Gabhane *et al*., 2012; Zhang *et al*., 2017; Barthod *et al.,* 2018), mineral (Wang *et al*., 2016), biological (Jurado *et al*., 2015; Awasthi *et al*., 2017) or a mixture of substrates (Hayawin *et al*., 2014; Awasthi *et al*., 2018). The addition of substrates improves the contents of the nutrients and accessibility in the final product (Gabhane *et al*., 2012; Morales *et al.*, 2016). Vegetable markets are present in every city and town place which produces a significant amount of non-edible vegetable and fruit wastes (Karuppasamy *et al.,* 2016; Jara-Samaniego *et al*., 2017). Fruit and vegetable wastes are the plant-tissue waste generated on farms, markets, or homes and are highly putrescible (Musa *et al*., 2020), stale or spoilt, and not fit for human utilization. These materials are ordinarily high in fiber content and are highly damp in with a value of 80-89% (Das & Mondal, 2013). Due to its elevated natural and dampness characteristic, the vegetable and natural product wastes can be contemplated as a valuable and promising raw material for bioconversion into nutrient-rich natural biofertilizers that can be a perfect substitute for chemical fertilizers. Tratsch *et al*., (2019) mentioned that vegetable and fruit waste can be a nitrogen resource for plants when composted. Ghinea and Leahu in 2020 reported the production of compost at laboratory level from fruit (apples, bananas, kiwis, and oranges) and vegetable (cabbages, carrots, and potatoes) waste collected from different Romanian households and canteen. If the compost is enriched with symbiotic and non-symbiotic nitrogen-fixing organisms it results in a beneficial effect on the growth of plants (Htwe *et al.*, 2019). Bacteria can beneficially contribute to plant growth via N2-fixation and solubilization of low mobile nutrients. Hence application of microbial inoculants is of strategic interest for their potential to replace chemical fertilizers and pesticides in agricultural systems, and improve environmental sustainability (Dal Cortivo *et al.,* 2020).

Besides this sugarcane industry is the major agro-based industry which contributes a large amount of distillery spent wash (DSW) as the major by-product (Rengaraj & Sultana, 2014). It is rich in organic load, contains some soluble salts and essential plant nutrients (Nawaz *et al*., 2019; Shinde *et al.*, 2019), organic carbon, TSS, TDS, and proteinaceous substances, making it a potent agricultural input. Also, DSW is free from any toxic metal since it is of plant origin and contains several micronutrients (i.e., Fe, Cu, and Zn) and macronutrients (i.e., N, K, S, P), Therefore, for the major crops and vegetables, it is an ideal source of nutrients. In a study, it was reported that 25% DWS (liquid DSW) expounded the uptakes of N, P, and K and the yield of, grain weight of Wheat (*Triticum aestivum L*., (Chattha *et al*., 2018). Similarly, Liquid DSW was found to increase the growth of Sesame (*Sesamum indicum L.*, (Vadivel *et al*., 2019), as well as Maize (*Zea mays L.*) and Finger millet (*Eleusine* coracana (L.) (Bhaskar *et al*., 2018). As compared to the application of inorganic fertilizers and control (no fertilizer), diluted DSW when employed in sugarcane growth increased cane size and yield (Rath, 2011; Kaloi *et al.,* 2017). Likewise, reports indicated that enhanced chlorophyll contents (Jain & Srivastava, 2012), improved the growth, and yield were all the results of the utilization of DSW which nonetheless caused improvement in photosynthesis and subsequently better production. Co-composting of food market wastes with DSW produced a better-quality compost with appropriate agronomic properties for use as natural natural fertilizers and with no phytotoxic properties (Umair Hassan *et al*., 2021).

The present study deals with the preparation of bio compost from waste vegetables and fruits picked from the local market and normal household activities, enrichment of compost with the nitrogen-fixing microorganisms, cow-dung, and distillery spent wash and application of prepared compost for the growth of wheat, mung, and groundnut plants.

MATERIALS AND METHODS

Sample collection

Different non-edible vegetables and fruits were collected from the local vegetable market at shahada. Besides it, regular household vegetable peelings and cuttings waste were collected, cut into pieces, sun-dried for 4-5 days, and powdered. This vegetable waste powder was mixed with soil in equal proportion (1:1) in a large drum and the mixture was watered to maintain humidity and to become homogeneous for a week.

Isolation of Azotobacter

Isolation and identification of non-symbiotic nitrogen-fixing organism *Azotobacter* was carried out by inoculating 1 gm rhizospheric soil sample into the sterile nitrogen-free Ashby's mannitol salt broth flask and incubated for 6-7 days at RT. After 7 days surface growth was inoculated into sterile nitrogen-free Ashby's mannitol salt agar plate and incubated plate at RT for more than 3 days. Mucoid, transparent colony of *Azotobacter* on Ashby's mannitol salt agar plate was selected, purified further, and confirmed by morphological and biochemical tests. Pure culture of the isolate was maintained on Sterile nitrogen-free Ashby's mannitol salt agar slant and Nutrient agar slant and stored in the refrigerator.

Isolation of Rhizobium

Symbiotic nitrogen-fixing organism *Rhizobium* was isolated from freshly collected healthy nodules of the nodulated plant and inoculated in a sterile congo red yeast extract mannitol salt agar plate for 48-72 h. Pink-colored, large, gummy isolated colonies were purified further and confirmed by morphological and biochemical tests. The pure culture was maintained on sterile congo red yeast extract mannitol salt agar slant and stored in the refrigerator.

Inoculation of specific organisms, cow-dung, and distillery spent wash into compost

After one week the homogenous mixture of soil and vegetable waste powder was inoculated with the liquid broth cultures of nitrogen-fixing *Rhizobium* & *Azotobacter* organisms and allowed to settle for two days. After two days sample was inoculated with some cow dung & a two-liter distillery- spent wash sample, was collected from Shri Satpuda Tapi Sugar Factory and distillery section. Purushottamnagar, shahada. Nkansah *et al*., (2022) reported the use of cow manure as a nutrient amendment in recycling food waste biocompost production and results in production of high quality compost with increased usage in agriculture.

The inoculated mixture was mixed thoroughly and incubated for 4-8 weeks. After 8 weeks again all content was mixed thoroughly and incubated for two-three weeks.

Application of vegetable compost for the growth of plants by pot culture assay

Wheat (*Triticum aestivum L.,*), mung bean (*Vigna radiate L.,*) and ground-nut (*Arachis hypogaea L.,*) were purchased from the local market of the Shahada region. Seeds were soaked overnight in sterile distilled water and sown in experimental pots containing vegetable compost and sterile soil in a 2:1 ratio. In each set, about 10-15 seeds were sown. The seedlings were germinated within 48 to 72 hours. Pots were watered daily, plantlets were observed after 45 days, and morphological growth parameters like root length, shoot length and plant height were measured in cm chlorophyll content in g/lt was estimated by the method described by Jayaraman (2011), and recorded accordingly. One experimental set was conducted with chemical fertilizer (urea) while control was maintained without fertilizer treatment.

RESULTS AND DISCUSSION

The non-edible, waste vegetables and fruits are organic in nature, and rich in carbohydrates and proteins. This waste when inoculated in soil with biofertilizer producing microbes like *Rhizobium and* Azotobacter, cow-dung and distillery spent wash, other saprophytic microbes present in waste vegetables and fruits, cellulose-degrading isolates, and several useful bacteria present in cow-dung and distillery spent wash, utilized the complex organic substances and converted the waste into a reusable fertilizer by improving the quality of compost with adequate amounts of organic carbon and nitrogen. By application of this fertilizer the seeds of wheat, mung bean, and groundnut have shown a better rate of germination and improved growth characteristics like, root length, shoot length, plant height, and chlorophyll content of the plant. The soil becomes enriched with organic carbon, phosphorous, potassium, and nitrogen for the growth of plants.

Morphological properties

When morphological properties like root length and shoot lengths were measured in centimeters data obtained revealed that increased roots and shoot length were observed **(Figure 2)** in seeds with vegetable waste bio-compost treatment as compared to chemical fertilizer and control **(Figure 1)**. Similarly increase in the plant height was found in the seeds treated with bio-compost. The maximum height was recorded in wheat seeds treated with bio-compost as compared to mung seed. Similarly, a maximum number of leaves 35in wheat seeds, and chlorophyll content of 0.106 ± 0.2 in groundnut seeds were observed in pots treated with fruit and vegetable waste compost. Results in **Table 1** revealed that significant variation in the number of leaves, as well as all other morphological parameters of plants, were observed due to the treatment of bio compost. Bio-compost enriches with distillery spent wash and cow dung was found to be highly nutritious for the growth of plants,

Germination percentage

Results obtained in **Table 1** revealed that seeds coating and treatment with bio-compost showed a higher germination percentage as compared to control (30%) and seeds coated with chemical fertilizer (40%). Maximum germination percentage was observed as 100% in all seeds treated with bio compost. Bio-compost enriched with DSW and microorganisms along with cow dung was found to be highly beneficial for the growth of plants.

Table 1. Effect of biocompost on the morphological properties of wheat, mungbean and Groundnut seeds

Seeds	Root length (cm)	Shoot length (cm)	Plant height (cm)	Number of leaves	Chlorophyllg/lit	%age Germination
(Control) Wheat	4.3 ± 0.3	5.4 ± 0.2	4.2 ± 0.2	15	0.40 ± 0.2	50
Mung bean	2.4 ± 0.1	4.5 ± 0.5	6.5 ± 0.4	10	0.23 ± 0.1	30
Ground nut	3.1 ±0.3	3.8 ± 0.2	5.8 ± 0.2	08	0.24 ± 0.4	40
FVW Bio-compost Wheat	10.4 ± 0.2	15.5 ± 0.4	16.3± 0.4	35	0.82 ± 2.2	100
Mung bean	5.7± 0.3	7.2 ± 0.1	11.5 ± 0.5	22	0.63 ±2.3	100
Ground nut	8.6 ± 0.2	12.5 ± 1.2	9.3 ± 2.2	19	0.106 ± 0.2	100
Chemical fertilizer Whetat	5.3 ± 0.2	8.6 ± 0.5	10.5 ± 0.2	10	0.73 ± 0.31	40
Mung bean	3.2 ± 1.1	4.4 ± 0.2	7.3 ± 0.4	05	0.61 ± 0.4	60
Ground nut	3.5 ± 0.2	4.8 ± 0.2	5.5 ± 0.3	03	0.73 ± 0.3	50

Values are the mean of triplicates

Figure 1. Growth of wheat and groundnut seeds with chemical fertilizer

Figure 2. Growth of wheat and groundnut seeds with Bio-compost

CONCLUSION

In every city in each house, some quantity of waste vegetables and fruits are generated which are non-edible in nature but these waste vegetables and fruits are highly organic, rich in carbohydrates and proteins. When symbiotic and non-symbiotic nitrogen-fixing organisms along with cellulose-degrading organisms present in cow dung were added to waste fruits and vegetables these organisms have utilized these complex organic substances and converted the waste into a reusable fertilizer by improving the quality of compost with adequate amounts of organic carbon and nitrogen In this bio-compost preparation method waste matter was converted into a bio-compost with the addition of DSW and converted into a product which can be utilized as an eco-friendly soil fertilizer. The house-hold kitchen waste can be utilized and decomposed by microbes and produce a higher quality of bio-fertilizer. When this bio-compost was applied for the growth of wheat, mung, and groundnut seeds improved morphological properties like an increase in root length, shoot length and better rate of germination was observed in seeds treated with bio-compost as compared to chemical fertilizer and control. Thus agro wastes like vegetables and fruits, enriched with distillery spent wash and biofertilizers producing isolates were.

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