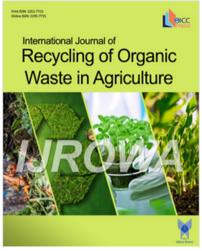

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Bioconversion of kitchen waste by *Pichia kudriavzeii* SGP1 (Sudhida Gautam Parihar1)

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Original Research

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Abstract:

Purpose: The study was undertaken with a purpose of at source bioconversion of wet kitchen waste. To accelerate the "Zero Waste Concept" and meet the UN's Sustainable Development Goals 2015.

Method: Wet waste was mixed with dry paper, cardboard material and a microbial culture was inoculated in the bag. Proper mixing of the material enhanced the process of composting.

Results: Microgold-Y had a pH range of 6.7 to 7.0 with 45 to 58% moisture content, and suitable for plant growth. Germination test using radish (*R. sativus*) revealed 100% sprouting between 24 to 48 hrs on Microgold-Y (10%) followed with 93.3% on Microgold-Y (20%) as against 96.6% in sand (control), grown in small containers (5×6 cm) at 20.2 to 20.7° C and 58 to 65% RH. Besides, profuse growth and flowering was observed in *B. monnieri* on Microgold Y while poor growth without flowering in control. Safety evaluation on earthworm, *E. fetida* revealed the survival of 60% as compared to 95% in control (cow dung). The worms produced undersized cocoons (<2 mm) on microgold as compared to control (2.7 to 3.7 mm) and interestingly regained their reproduction on pre-mature microgold.

Conclusion: The yeast was identified as *Pichia kudriavzevii* determined by the specialists at ICAR-Indian Agricultural Research Institute, New Delhi-12 based on NCBI Blast Result and FASTA Sequence. The pH and moisture content of the product (Microgold-Y) ranged from 6.7 to 7.0 and moisture ranged from 45 to 58 per cent, which are ideal attributes of good compost recommended for field applications.

Keywords: Sustainable development goals; Zero waste model; Microbial inoculum; Radish germination; *Bacopa monnieri*; *Eisenia fetida*

1. Introduction

India produces 277.1 million tons of solid waste every year, which is likely to touch 387.8 million tonnes in 2030. However, the information on Kitchen solid waste at a family unit is scanty. The non-edible part of fruit/vegetables like the peels, husk, seeds etc leads to generation of wet kitchen solid waste while dry organic waste (packaging material) comes through the marketing chain. The food waste poses an environmental threat when directly dumped in landfills which is exponentially rising with the growing populations. According to a paper entitled "Challenges and opportunities associated with waste management in India" published in the "Royal Society Open Science" in March 2017, urban areas alone generate 1,70,000 tons of waste per day. In this scenario, the informal sector has a key role in extracting value from waste, with approximately 90% of residential waste currently dumped rather than properly landfilled (Kumar et al., 2017). The local governments are responsible for the waste collection, transport, and disposal in most cities. It must cope with the increasing demands of a formal waste management system based on living with the "Zero Waste Model". Sustainable Development Goals (SDG) to ensure

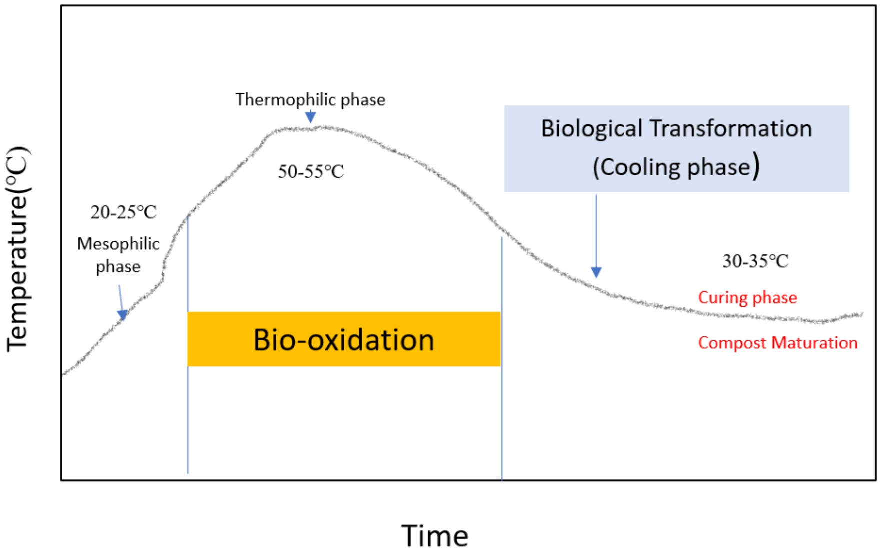

Figure 1. Three phases of Bioconversion/Composting.

harmony with the environment, proper management of food waste is an opportunity to address soil health and reduce greenhouse gas (GHG) emissions while also advancing economic development for a pollution free model (Singh et al., 2012). Suthar and Singh (2014) reported that household waste can be a potential resource for energy and manure production if proper waste management system is designed for the city based on a study conducted in Dehradun (India). The compost produced improves soil texture, has a good permeability and porosity. It also favours microbial growth which aids in soil binding. Nitrogen is stabilized which prevents the foul odour and production of leachate (Pandey and Hedaoo, 2021).

The byproducts contain 'humic-like' compounds that differentiate them from those found in native soil, coals, and peats. Composting is a means of transforming different degradable wastes into products that can be used safely and beneficially as biofertilizers and soil amendments (Yu et al., 2019). The temperature and available substrates are the key factors in the selection of species in microbial communities during composting (Takaku et al., 2006). Composting technologies have come a long way, developing from static heaps and windrow composting to smart, artificial intelligence-assisted reactor composting (Zhou et al., 2022).

Composting is an aerobic process when microbial agents reduce the organic waste into an organic fertilizer. The microbial inoculant is a vital component of a healthy ecosystem and prevents the addition of chemical fertilizers to increase the soil fertility. Forced aeration and upturning the compost pile supplies oxygen to the microorganisms and enhances the process of degradation. Aeration also stimulates the production of carbon dioxide, which is an exothermic reaction and helps to achieve high (thermophilic) temperatures quickly. A compost pile has an initial (Mesophilic) phase, Thermophilic phase and curing (Maturing) phase with temperature range of $20-25°$ C, $50-55°$ C and $30-35°$ C respectively Fig. 1.

Nitrogen loss through ammonia volatilization is prevented at mesophilic temperatures. Microbial additives, covering and compaction help to achieve mesophilic temperatures quickly. Periodical churning/turning of the pile introduces oxygen and prevents formation of anaerobic pockets. The anaerobic pockets favour production of methane and nitrous oxide, both are greenhouse gases having harmful effects on humans and plants. Methane is produced in the initial phases of composting while the carbon is readily available. Mixing the pile releases the methane directly in the atmosphere and eliminates the possibility of methane oxidation. The C:N ratio affects ammonia volatilization to a large extent and is an indicator of compost stability. Carbon binds to nitrogen and makes it unavailable for ammonification.

There are few fungi reported by earlier workers (Raut et al., 2008; Nakasaki and Hirai, 2017; Heidarzadeh et al., 2019; Rastogi et al., 2020) and earthworms (Zhijian et al., 2013; Sharma and Garg, 2017) to enhance the production of different enzymes resulting in better rate of waste degradation globally. Apart from it various yeast species have been exploited for ethanol (Oberoi et al., 2012; Avchar et al., 2022) and beer production in India (Ghosh et al., 2019) and greater flavour and aroma for cocoa beans (Greppi et al., 2017). However, its potential in composting has not been reported elsewhere except by Nakasaki et al. (2013) from Japan who demonstrated that the yeast strain *Pichia kudriavzevii* RB1 affected the early stages of composting prior to the thermophilic stage and accelerated the overall composting process. The addition of dry bulking agents and microbial additives change/affect the C/N Ratio and can reduce the emissions of ammonia and carbon dioxide. Strategies of turning and compaction also help in reducing the emission of greenhouse gases (Chandana et al., 2013; Sangamithirai et al., 2015). The involvement of the public at household level has not been exploited probably due to perception of it not being ecofriendly and hygienic. In this context, the judicious use of microbial additives is indispensable.

A unicellular fungus, *P. kudriavzevii* regarded as industrial

Figure 2. An account of pictorial presentation starting from yeast culture inoculation to production is produced in Plate 1. (a1) Yeast nucleus culture (b1) Colour appearance of culture (c1 & d1) Fruit & Vegetable peels (e1) Culture inoculation on kitchen waste.
(a2) Packed after inoculation for fermentation, (b2) Fermentation of compost, (c2) Premature Compost, (d2) Stored for maturation of Compost, (e2) Physical maturity check of Compost, (f2) pH and Moisture check of compost through a Moisture-cum-pH Meter, (g2) Compost named "Microgold-Y"(used in various experiments).

yeast is widely distributed in nature often occurring in soil, on fruits, in various natural fermentations and beverages. It produces colonies with a flat surface showing appearance of pale pink colour, downy or slightly velvety, dull, or dry in texture, and known to remain even metabolically active at high and acidic pH. Recently, *P. kudriavzevii* was reported as a potential candidate for improving the physical, chemical, and biological properties of the soil (Ramya et al., 2021) but as such no reports on its application in bio-waste conversion in India. Keeping in view, the present study was undertaken to develop a safe and effective strategy suitable for family-based units and in-house management of the kitchen solid waste, with the following objectives:

- Study aimed for proper disposal of wet kitchen waste by applying the 3R i.e., Reduce, Reuse and Recycle. An initiative for zero waste concept to manage the waste at the source of production itself.
- Assessment of Kitchen solid waste generated by a small family and at source conversion to abide by the Solid Waste Management Rules 2016 given by Central Pollution Control Board., MoEFCC of India.
- Isolation, identification characterization of yeast isolate, SGP1(Sudhida Gautam Parihar 1)
- Production of Microgold-Y (compost) using the yeast strain SGP1
- Influence of Microgold-Y on germination of radish seeds, and plant growth of medicinal herb, Bramhi
- Safety evaluation of Microgold-Y against earthworm, *Eisenia fetida*

2. Material and method

• Assessment of kitchen solid waste generated by a small family

With a view to assess the kitchen solid waste (non-cooked fruit and vegetable peels/seeds, cardboard and paper packaging material) generated by a small unit (4-member family comprising a child and three adults) was quantified (Kg) on daily basis for a period of seven chilling weeks between 22nd November 2021 to 7th January 2022. Data was tabulated and converted into average using Jamovi Statistical Tool.

• Isolation and determination of yeast identity

During rain in the month of August 2020, banana, grape, apples and with potato (*Solanum tuberosum*) and other vegetables were purchased from a street vender. Of which, a racked and rotting potato tuber suspected to be infected was soaked in RO water and stored in a flask for 2 days at room temperature. Thereafter, the turgid water (extract) was mixed with freshly grinded wheat (*Triticum aestivum*) flour in the ratio of 3:1 to observe bubbling and the smell of alcoholic fermentation. The fermented stock (10 g) was equally divided in three parts. Each part was kept in separate airtight individual glass bottles (16 $\times$ 6.5 cm) adding equal quantities of flour, inoculum, and distilled water. The best performing material was selected based on shortest fermentation time through a journey of several repeats. The rigorous mechanism of isolation and testing for a period of 6 months (August to January 2021) at room temperature was completed, and thereafter, subjected to identification by way of outsourcing.
Initially, the specimen based on type collection was identified as *Pichia kudriavzevii* at ITCC, Division of Plant Pathology, ICAR-Indian Agricultural Research Institute, New Delhi-12. The identity of yeast was determined by outsourcing and subjected to BLAST analysis followed with submission to the Genbank to get accession number (Parihar and Gautam, 2022). The purified nucleus culture kept in the airtight glass bottles was stored at 10° C in the refrigerator for experimentation.

• Bioconversion of kitchen solid waste to compost

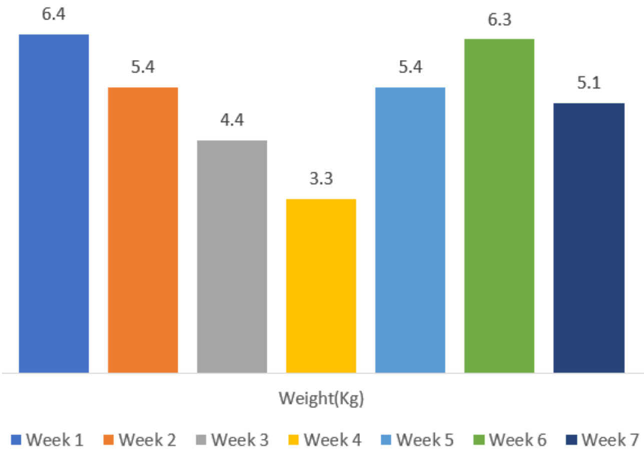

Figure 3. Weekly, quantification of organic kitchen waste.

using SGP1

Household waste (wet greens: fresh vegetable and fruit peels and dry carbon: packaging material generated through purchases of goods and scrap papers). The Carbon: Nitrogen (1:4) ratio of garbage was maintained using 200 g dry (Carbon) and 800 g green (Nitrogen) materials to avoid anaerobic fermentation responsible for greenhouse gases (Fig. 2). The inoculum of *P. kudriavzevii* at the dose of 100 g/kg of garbage was administered on a daily basis. However, in the control only 200 g dry garbage and 800 g green was added (No inoculum). Twenty replicates were maintained in individual plastic bags after weighing the quantity of wet and dry waste. The treated garbage secured inside the plastic garbage bags (1 Kg capacity), was placed in the balcony for decomposition. The plastic bags were easy to handle and thoroughly agitated/churned by hand after opening on a regular basis to fasten the aerobic fermentation for a period of 8 to 9 weeks or till it attained maturity. The oxygen helps in the oxidation of several sorts of organic substances in a composting material, also it is used by the microorganisms as a terminal electron acceptor for aerobic respiration (Bertoldi et al., 1983). The mixing of the plastic bags content helpes to assure proper turning of waste and acceleration of the bioconversion by aerobic process and prevents the foul generated from the decomposing waste (Amritha and Anilkumar, 2016). Dried composted material named as "Micro gold-Y" was sieved and stored at room temperature for other studies.

• Physicochemical characterisation of "Microgold-Y"

The important basic quality parameters of compost viz., degree of acidity (pH), moisture content, germination and plant growth on mature compost were tested following standard methodology. The moisture content (%) and pH of the product were checked using a Moisture meter (3-in one: Moisture Meter, pH Meter and Light Meter) recommended for soil testing for the gardeners. A quantity of 300 g Microgold-Y (decomposed material-Compost) was thoroughly mixed and poured in a plastic container (10 × 9 cm) to weigh on a balance having accuracy of 10 g to 2 Kg. Thereafter, the knob of the moisture meter was changed to a moisture scale before inserting its probe into the centre of the container. The reading was then recorded on moisture scale after 10 minutes of insertion. Similarly, pH value was recorded on pH scale by shifting the knob at pH point of the aforesaid meter for 5 minutes. A total of 20 replications were examined for pH and moisture content in order to reach an average figure apart from the moisture content during the 10th week of experimentation.

• Suitability of Microgold-Y on germination of radish seeds, and growth of medicinal herb, Bramhi

Suitability of Microgold-Y was tested under pot conditions in Pitampura, Delhi against widely recommended germination test using radish (*Raphanus sativus L.*) and overall growth, flowering and yield of a medicinal herb, Bramhi (*Bacopa monnieri*), and evaluation of safety against the earthworm, *E. fetida* using standard methodologies.

• Germination test of Radish

A total of 10 healthy seeds of Radish (Var. Pusa Chetki) were placed in the containers (size: 7.5 × 6.5 cm)

Table 1. Physicochemical properties of Microgold-Y.

Physicochemical Parameters	Minimum value (mean of 20 replicates)	Maximum value (mean of 20 replicates)	Mean value (pooled 20 replicates)
pH value	6.7	7.0	6.9
Moisture content (%)	45	58	54

Table 2. Temperature and humidity of room from 25 to 27 December 2021.

Date	Parameters	Periodic observations				Mean
		6hr	12hr	18hr	22hr	
25 Dec. 2021	Temperature (° C)	20.2	21.0	20.2	19.9	20.3
	Humidity (%)	58.0	62.0	64.0	59.0	60.7
26 Dec. 2021	Temperature(° C)	20.0	21.3	20.7	21.1	20.3
	Humidity (%)	65.0	67.0	69.0	68.0	67.2
27 Dec. 2021	Temperature(° C)	20.6	21.0	21.2	21.4	21.5
	Humidity (%)	62.0	63.0	62.0	62.0	60.2

in three replications. There were three treatments namely 10 per cent (10 g Microgold-Y mixed with 90 g Sand) and 20 per cent Microgold-Y (20 g Microgold-Y mixed with 80 g Sand) along with control (100% Sand). The pH of Micro-gold-Y and sand used were 7.1 and 7.0 while moisture content was 61 and 14 per cent, respectively. Before seed sowing soil was gently poured with 25 mL water in each treatment to create ideal conditions for germination. Light shower of water was applied at the interval of 8 hours to containers for maintaining ideal conditions. The containers were placed in a room maintaining 20.2° C to 20.7° C temperature and 58 to 65 percent humidity wef 25 to 27th Dec 2021 (To monitor the germination period of radish in a controlled environment). The temperature (° C) and humidity (%) of the experimental room were recorded using a digital Temperature and Hygrometer (HTC-1) at 6, 12, 18 and 22 hrs regularly. Observations on germination were recorded at 18, 24, 30, 36, 40, 44 and 48 hours after sowing. Standard agronomic practices were followed in the case of raising radish crops. Observation on germination was counted in cumulative manner daily for five days after sowing. However, viability of plants was noted on the 10th day based on their normal growth in each treatment along with plant height and formation of terminal shoots. Data was converted into percentage. Data was statistically analyzed for Mean values using "Jamovi Statistical Software".

• Influence of Microgold on Bramhi Plant growth and yield

Bramhi (*Bacopa monnieri*) a medicinal plant also, known as water hyssop, thyme-leaved gratiola, and herb of grace was chosen for study due to the facts viz., short duration (75 – 90 days) crop with a potential to grow on the soil with wide range of pH (6 to 7.5), propagation through fresh cuttings and ability to grow under diverse range of temperature (15 to 40° C). A total of 20 plants were raised for four months starting from 22nd May 2021 in plastic pots (10" diameter) using standard agronomic practices. Data on morphometric and yield was generated to study the influence of Microgold-Y compared with garden soil. The length of 30 shoots (cm), number and length of internodes (mean of 10), number of branches (mean of 30), root length (mean of 10), total plants (no.), flowers per pot on week one (mean of 10) and yield (g) were recorded.

• Safety evaluation of Microgold-Y against earthworm, *Eisena fetda Savigny*

The earthworm *E. fetida* is well explored as an organic decomposer along with safety concerns (Xiao et al., 2022) and utilized in enhancing the crop productivity (Sushilkumar and Singh, 2018). A total of 50 cocoons collected from the stock culture of earthworms on cow dung were separated in transparent plastic containers (7 × 12 cm) on 4th November 2021 to observe their length, hatching and number of juveniles hatched per cocoon. The length of 10, 12 and 15 cocoons per group was measured on a normal scale (30 cm), and mean length of each group was calculated. The containers having 20 mL RO water along with cocoons in groups of 20, 20 and 10 were placed at room temperature (19.4 to 24.4° C) and 49 to 69% RH. The floating cocoons were removed and discarded. The juveniles (0 – 48 hrs) hatched from these cocoons were gently transferred using camel hair brush No.1 on 300 g each of cow dung (11 neonates) and Microgold-Y (11 neonates) separately to compare their feeding, development, and survival on this substratum for a period of two months. The observations namely clitellum development (day), cocoon laid on first day, and hatching were recorded apart from survival (%).

Table 3. Germination of Radish in ascending order of periodic progression.

Treatment	Germination (%) and time frame						
	18hr	24hr	30hr	36hr	40hr	44hr	48hr
10 % Microgold-y	0	23	73	87	87	90	100.0
20 % Microgold-y	0	20	60	77	77	93	93.3
100 % Sand (Control)	0	30	50	80	83	87	96.6

Figure 4. (a) Radish growth on Microgold-Y (10%), (b) Radish growth on Microgold-Y (20%), (c) Radish growth on Sand (control), (d) Bramhi transplanted on 22nd May 2021 through terminal shoots, (e) Poor growth of Bramhi in control, (f) Profuse growth of Bramhi in Microgold-Y (10%), (g) Bramhi flowered in Microgold-Y treated pot.

3. Results and discussion

Assessment of kitchen solid waste generated by a family

Fig. 3 revealed the generation of organic kitchen waste ranging from 3.3 to 6.4 Kg per week. A great variation on a daily basis was observed between 200 g to 1600 g depending on the consumption of specific vegetables/fruits with regards to seasonal availability. Suthar and Singh (2014) reported a minimum 215 g (approx.) organic waste (food kitchen waste, cardboard, and paper). They also reported the amount of house waste generated in the city of Dehradun (India) ranged from 24.5 – 4147.1 g/day depending on family size and its socioeconomic condition.

Isolation and determination of yeast identity

Isolated material suspecting yeast was identified by ITCC, New Delhi as *Pichia kudriavzevii*. Subsequently, an accession number OM574927.1 describing *Pichia kudriavzevii* isolate SGP1 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene and internal transcribed spacer 2, complete sequence; and large subunit ribosomal gene, partial sequence was granted on 13th February 2022 (Parihar and Gautam, 2022).

Bioconversion of kitchen solid waste to compost using SGP1

Compost maturity is the degree or level of completeness of the composting process to produce a stable product and it normally takes a month to year depending on method used. The compost (henceforth termed as Microgold-Y) in the present study was produced within a period of 60 days using semi-solid stock of *P. kudriavzevii* 200 g/kg kitchen refuge, a mix of 800 g green (nitrogen) and 200 g dry (carbon).

It is evidenced that *P. kudriavzevii* accelerates organic matter degradation which is an agreement with the findings of Nakasaki et al. (2013). The microgold-Y possessed the parameters viz., moisture content (45 – 48%) and pH (6.9 to 7.1) of an ideal compost as also supported by earlier workers (Tiquia and Tam, 2000; Sushilkumar and Singh, 2018). The mature compost is normally dark black in colour, crumbly in texture with a pleasant earthy, soil-like smell.

During this period, the process of decomposition passed through a range of temperatures (25 to 45° C). In non-treated kitchen wet waste (control) strong off smell (unbearable) was observed. Strains of *P. kudriavzeii* are reported as thermotolerant to work effectively at elevated temperatures ranging from 35 to 45° C (Dhaliwal et al., 2011; Chamnipa et al., 2018) agree with the present findings.

Physicochemical characterisation of "Microgold-Y"

Microgold-Y had a pH range of 6.7 to 7.0 and 45 to

Figure 5. Earthworms (a) Measurement of Cocoons, (b) Neonate hatched from cocoon, (c) Rearing of young juveniles in small jar, (d) Rearing of grownup juveniles for further development in dust bin to safeguard worms from overcrowding and defenders, (e) Worms developed on cow dung, (f) Worms developed on Microgold-Y.

Table 4. Biological attributes and yield of Bramhi grown on Microgold-Y.

Treatment	Biological attributes and yield						Total Plants/plantlets developed	Total yield (g)
	Shoot length (cm)	Internode (no.)	Mid-internode length (cm)	Branches (no.)	Flower (no.)	Root length (cm)		
Microgold-Y	30.7	25.4	2.0	5.8	2.7	5.45	110	130
Garden soil (Control)	14.9	13.6	1.6	2.8	0.0	4.19	30	25

58% moisture content. However, all the replications pooled together maintained 6.9 and 54% value of pH and relative humidity (Table 1). These parameters are good characteristics of ideal compost having pH between 5.0 to 7.0 and 40 to 60 per cent moisture by weight as reported by earlier workers (Ameen et al., 2016), which is in agreement. The pH value of 7 indicates the neutral range. However, most plants ideally grow in the neutral to slightly acidic range.

Suitability of Microgold-Y for germination of radish seeds, and growth of medicinal herb, Bramhi
Germination test of Radish

Germination test of radish seed revealed 100 per cent germination (Table 2) at room under controlled environment temperature (Table 3) between 24 to 48 hrs on Microgold-Y 10 and 20% followed with 96.6 per cent in control. Further, better viability of 84 to 85 per cent was observed in Microgold-Y as compared to 53% in control attaining height up to 5 cm on 5th day of sowing and developed up to 15 cm as a plant sub-sequently without addition of substratum (Fig. 4). Study thus has proved the potential of Microgold-Y (10 to 20%) as safe and effective compost as soil amendment. Radish (*R. sativus*) being a short duration crop is widely recommended for germination tests of various composts by different workers (Warman, 2013). Three days from 25th Dec 21 to 27th Dec 21 during the germination period of the radish seeds the pots were in a controlled environment after which they were shifted to an open environment. The temperature and humidity of the controlled environment are given in Table 3.

Influence of Microgold on Bramhi Plant growth and yield

Morphometric studies (Table 4) revealed that Microgold-Y performed better over control in terms of shoot length, number and length of internodes, number of branches, root length, total plants and yield. Besides, there was no flowering in control as against profuse flowering in the month of September 2021 for the first time in Microgold-Y indicating it is better fortified soil to produce Bramhi. It may be noted that plant brought from Jabalpur in 2018 till September (wet season) 2021 did not flower although they survived in Delhi weather. In terms of yield, a 5-fold increase (130 g) of green matter from Microgold-Y treated plants as against 25 g in control was observed.

Safety evaluation of Microgold-Y on earth worm

Observations revealed that Microgold-Y was accepted by the earthworm for feeding, and shelter immediately after releasing it similar to the control. The survival of 60 per cent on Micrgold-Y was noted as against 95 per cent on cow dung, a well adopted substratum for axenic rearing. The differences in poor survival on Microgold-Y may probably be due to a new and almost fully decomposed substratum as worms are known to feed on semi-decomposed material that warrants further studies. Further, studies indicated that clitellum development, initiation of cocoon production were comparable. However, scanty undersized (< 2 mm) cocoons were laid on Microgold, which did not hatch (Table 5). Clitellum development period of 3 weeks and number of juveniles per cocoon (2 to 4) when reared o cow dung at room temperature of 21 – 28° C and 60 to 80% reported by Ali and Kashem (2018) are supportive to the present study keeping in view the variations in the environmental conditions. An account of safety to earthworm (juvenile and other stages) and rearing are presented in Fig. 5 as

Table 5. Safety evaluation of *E. fetida* reared on Microgold-Y.

Biological attributes	Earthworm Survival (%)	Clitellum development (day)	Start of cocoon production (day)	Cocoon length (random) (mm)*	Hatching (%)	Incubation period (day)	Neonates per cocoon (no.)
Microgold-Y	60	37	50	< 2.0 (10) -(12) -(15)	0	-	-
Cow dung	95	36	45	3.7(10) 3.3(12) 2.7(15)	70	22.5	1-2

Note:* Number in Brackets indicate Random group of cocoons i.e. 10, 12 and 15.

well.

4. Conclusion

The following case study deals with a family of 4 members including a child which generated 3.3 to 6.4 Kg per week of wet kitchen waste. Applying the Zero waste model, the wet kitchen waste produced was decomposed to yield the compost and termed as Microgold-Y. Waste produced was inoculated with microbial inoculum primarily consisting of yeast and mixed with dry paper/cardboard. The identity of yeast as *Pichia kudriavzevii* was determined by the specialists at ICAR-Indian Agricultural Research Institute, New Delhi-12 based on NCBI Blast Result and FASTA Sequence. The pH and moisture content of the product (Microgold-Y) ranged from 6.7 to 7.0 and moisture ranged from 45 to 58 per cent, which are ideal attributes of good compost recommended for field applications.

The Microgold-Y (mature compost) qualified the safety tests in terms of germination on radish (100%) as opposed to 96.6 per cent in control (sand). Bramhi (*B. monnieri*) planted through shoot-cuttings enhanced 5-fold increase (130 g) of green biomass from Microgold-Y treated plants as against 25 g in control. Profuse flowering occurred in treated pot as against zero in no-treated pot. Safety of Microgold-Y against the earthworm, *Eisenia fetida* was evaluated and found that the worm fed well on it and survived (60%) as compared to those fed on cow dung (95%).

Acknowledgment
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Ethical approval
This manuscript does not report on or involve the use of any animal or human data or tissue. So the ethical approval is not applicable.

Author contribution
All the authors have participated sufficiently in the intellectual content, conception and design of this work or the analysis and interpretation of the data (when applicable), as well as the writing of the manuscript.

Availability of data and materials
Data presented in the manuscript are available via request.

Conflict of interest statement
The authors declare that they are no conflict of interest associated with this study.

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