

Growth and Reproduction Rate of *Eisenia fetida*, using *Lagerstroemia speciosa* and Waste Disposable Face Masks to Test the NPK Level of the Compost

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Authors' contributions

This work was carried out in collaboration among all authors. Author PSS designed the study, wrote the protocol, and wrote the first draft of the manuscript. Author RK did the experimental work, performed the statistical analysis. Authors SP and GG managed the analyses of the study, managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The main objective of the study is to estimate the NPK produced in the waste disposable of a Face Mask (FM) is decomposed with a medicinal plant *Lagerstroemia speciosa* (LS). The experimental design consists of 5 groups; each group contains yard soil, cow dung, and coir pith as compost bedding materials. T1 - control, T2 - KWCO, T3 - FMCO, T4 - LSCO and T5 - ESLS. The result shows that the growth rate of *Eisenia fetida* depends on the length and weight of worms. The

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reproduction rate varies depending on compost materials, with higher rates in T4 and lower rates in T1. The T5 shows a high level but is a little lower than the T4. Juvenile numbers are low in T2 and T3 trials. NPK Level: The nitrogen level $413.2 \pm 2.90^{**}$ is highest in T4 and T3 is 404.3 ± 1.78 . Low in T1 336.6 ± 2.84 trial, moderate in $376.3 \pm 3.13^{**}$ T2 trial and T5 consist of $372.3 \pm 2.59^{**}$. The Phosphorus is commendably high in T5 $1011.3 \pm 2.59^{**}$ and T1 contains 992.3 ± 3.06 . The moderate amount is in T4 $894.3 \pm 2.22^{**}$. The lowest level of P $623 \pm 2.94^{**}$ is in T2 and T3 contain $676.6 \pm 2.88^{**}$. The potassium amount is varying in each trial. T1 is the most prominent amount of Potassium, and the level of K is 1900.3 ± 1.18 . The kitchen waste T2 trial produced $1840.6 \pm 2.37^{**}$ and the amount of K is in $1670.3 \pm 1.18^{**}$ T4. The most important face mask blue and black colour samples is mixed with kitchen waste T3 produces $1700 \pm 3.77^{**}$ and medicinal Plant T5 which produces $1569.3 \pm 2.84^{**}$. Our conclusion is that the medicinal plants had a significant effect on the growth and reproductive rate of red wigglers, and this effect was positively correlated with the NPK level in the soil.

Keywords: *Lagerstroemia speciosa* (LS); Face Mask (FM); Kitchen Waste (KW); Compost (CO); Experimental Sample (ES).

1. INTRODUCTION

Medicinal Plants contain high amounts of specific minerals that are used to enrich the fertility of the soil. Waste materials of medicinal plants help to increase the specific mineral content. The plants used were Neem cake, Citrus lemon [1], Eucalyptus, and Lemon grass [2]. These medicinal plants contain many substances as antibiotics, antiseptics, phenolic compounds, alkaloids [3], tannins, volatile oils, triterpenoids [4] antibacterial, antifungal [5,6] and antiviral compounds [7]. The ornamental and medicinal plant is commonly known as crape myrtle. *Lagerstroemia speciosa* comes under the family Lythraceae. It is popularly known as Poomaruthu and is native to Southeast Asia, but has been introduced to many other parts of the world due to its attractive flowers and usefulness in traditional medicine.

Wearing a disposable non-medical mask is one of the preventive measures recommended by health organizations to reduce the spread of COVID-19. Bacteria, skin flakes, and toxic substances are found inside the dirty masks. There are some practical difficulties with the decomposition of face masks. These practical difficulties arise due to the presence of synthetic materials in the masks, which can take hundreds of years to decompose and can release harmful chemicals into the environment during the process. Therefore, proper disposal and recycling of face masks are crucial for minimizing their negative impact on the environment. For safety purposes, we use the unused facemask for our experimental work. Additionally, the facemask should be disposed of properly after use to prevent contamination.

Eisenia fetida are the most common and widely used composting worms. Red wigglers eat most kinds of food scraps, including fruits and vegetables. It is important to note that red wigglers do not consume meat or dairy products. A mature worm produces one cocoon on every third day and one to three baby worms emerge from each cocoon for hatching after three to four weeks of incubation. *E. fetida* is an earthworm that grows rapidly [8], reproduces prodigiously [9], and is potentially deployable for the management of wastes rich in microbial biomass [10]. The increase of temperature resulted from the rapid breakdown of readily available organic matter and nitrogenous compounds [11]. Vermicomposting has also been found to have positive effects on some aromatic and medicinal plants [12]; [13].

Vermicomposting enhances soil biodiversity, plant health and increases agricultural production by treating waste safely earthworms converts waste into nutrient-rich compost, regulating soil environment and creating a good habitat for micro biota in sustainable agriculture. The aim of the work to analysis the bio-engineers growth, reproduction and compost production from degradable face masks using medicinal plants.

2. MATERIALS AND METHODS

2.1 Collection and Identification of the Experimental Plant

The experimental plant *Lagerstroemia speciosa* is collected at Golpalapuram village, Chittur block, Palakkad district of Kerala state, India.

The *L. speciosa* was identified and authenticated at the Botanical Survey of India, Coimbatore – 03. (No: BSI/ SRC/ 5/ 23/ 2020/ Tech/ 237).

2.2 Processing of Experimental Plant

The collected leaf samples were completely chopped, dried for seven days, and weighed. After scorching, the leaf was weighed again, and the dry weight was 2.200 kg. The dried leaf was used in T4 and T5 Trials.

2.3 Collection of Kitchen Waste

Kitchen waste is organic in nature that decomposes quickly, producing foul odors and attracting rodents and insects. Management of kitchen waste reduces or eliminates adverse impacts on land, contamination of the atmosphere, soil, and water. Kitchen waste collected from the ladies' hostel and college canteen, Government Arts College, Coimbatore - 18. The collected kitchen wastes were prepared for composting. The total trash weight was 7kg.

2.4 Pre-Composting of Experimental Sample

The experimental sample was taken into two types of unused facemasks. The total weight of the mask bits is around 250g. For simple composting the mask cut into small pieces and then soaks into the plain water for 24 hours. The soaked mask bits are mixed with Bio Monas and Shield Plus. This was allowed for pre-composting for 40 days. The partially composed mask bits were used in Trial T3 and T4.

2.5 Collection of Bedding Materials

For composting purposes, the collection of coir pith, cow dung and yard soil are used as a bedding material.

2.6 Experimental Animal

Earthworms are considered natural bioreactors which proliferate along with other microorganisms and provide the required conditions for the biodegradation of waste. The earthworm *Eisenia fetida* was purchased from the Vermigold organics (ESTD. 2004) (G5GC+W63) Aanaimalai - Dhali road, Udumalpet, Tamil nadu 642132, India. The *E. fetida* is commonly called red wriggler or red worm. The *E. fetida* is a well-adapted, short-life span species with a high reproduction rate.

2.7 Rice Wash Water

Rice wash water can be beneficial for simple composting because it contains minerals and nutrients. Fermenting the rice water can also help to promote healthy bacterial growth to increase the moisture in the compost.

2.8 Experimental Design

The control is T1, which consists of yard soil (5kg), and the kitchen waste (KWCO) along with compost bedding materials (1:1) is placed in T2. Likewise, T3 (KWCU) contains mask bits and trash (1:3). The substrates for vermicomposting were prepared by mixing 250 g of *L. speciosa* in the two types of trials. T4 consisted of experimental plants (1:1:2) mixed with compost bedding material (LSCO), and T5 consisted of experimental plants mixed with experimental samples (LSCU) along with compost bedding materials (1:1:2). The rice wash water is used to maintain the moisture content of the substrate at 60–65% for some time to facilitate the preliminary decomposition of materials. After an undisturbed 7-day composting period, the content in the replicates was mixed, and moisture content was checked along with earthworm activity. After that period, 20 adult worms were added to each trial. All the experimental setup was carried out at the PG and Research Toxicology Lab, Department of Zoology, Government Arts College, Coimbatore.

2.9 Growth and Reproduction Rate

Every 15 days for 65 days, the worms were hand sorted and weighed. The weight of earthworms was measured weekly in each container to decide the growth performance. Earthworms were hand sorted and weighed weekly to measure their growth performance. Cocoon production was observed weekly and the total number of cocoons was recorded. 10 freshly laid cocoons were transferred to plastic boxes to determine hatching success.

2.10 Parameters

Composting requires moisture, microbial activity, aerobic conditions, temperature, pH, and the weight method to determine the fertility rate of the soil.

2.11 Statistical Analysis

Statistical significance ($P=0.05$) is determined by one-way ANOVA, and values are shown as the mean \pm SEM. The earthworm growth and reproduction were compared using one-way analysis of variance.

3. RESULTS

3.1 Pre-Composting

The experimental sample is an unused face mask made of polypropylene. It also consists of micro-plastics. Before experimental work, the mask bits are mixed with Bio Monas and Shield Plus, and allowed to decompose for 15 days. This helps to avoid overheating in the vermicomposting system.

3.2 Growth and Reproduction

The length and weight of the worms determine the growth rate. At that time, worm pairs attained an average weight of about 1.69 g. The growth rate of *E. fetida* was significantly higher ($P=0.05$) in T4. The reproduction rate of each trial varies; it depends on the compost materials. The reproduction rate is greater in T4 and lower in T1. The T5 shows a high level but is a little lower than the T4. The juveniles are low numbers in T2 and T3 trials (Table 1).

3.3 NPK Level

The nitrogen level 413.2 \pm 2.90** is highest in T4 and T3 is 404.3 \pm 1.78. Low in T1 336.6 \pm 2.84 trial, moderate in 376.3 \pm 3.13** T2 trial and T5 consist of 372.3 \pm 2.59**. The Phosphorus is commendably high in T5 1011.3 \pm 2.59** and T1 contains 992.3 \pm 3.06. The moderate amount is in T4 894.3 \pm 2.22**. The lowest level of P

623 \pm 2.94** is in T2 and T3 contains 676.6 \pm 2.88**. The potassium amount varies in each trial. T1 is the most prominent amount of Potassium, and the level of K is 1900.3 \pm 1.18. The kitchen waste T2 trial produced 1840.6 \pm 2.37** and the amount of K is in 1670.3 \pm 1.18** T4. The most important face mask blue and black colour samples is mixed with kitchen waste T3 produces 1700 \pm 3.77** and medicinal Plant T5 which produces 1569.3 \pm 2.84** (Table 2).

3.4 Parameters

The optimum level of pH is in T2 and T4. The pH of T2 consists kitchen waste and trash produces 7.17 \pm 0.04 and the medicinal plant of *L. speciosa* dried leaf produces 7.21 \pm 0.01 pH in T4 Trial. The Yard soil T1 produces 7.42 \pm 0.08 pH, and the experimental samples of T3 and T5 produces 7.32 \pm 0.04 and 7.31 \pm 0.02 pH level. In the initial stage the oxygen demand is higher, so the development of microorganism is high. Temperature is an essential component of composting. As organic material decomposes, heat is produced. Increased temperature results in increased rate of biological activity. The moisture content of 70%–80% was retained by sprinkling water daily in the beddings.

Table 1. Reproduction rate of different compost media

| Trails | Before | After |
|-----------------|---------------|----------------|
| I | 25 \pm 1.53 | 380 \pm 2.52 |
| II | 25 \pm 3.79 | 451 \pm 4.00 |
| III | 25 \pm 2.08 | 419 \pm 4.51 |
| IV | 25 \pm 2.65 | 563 \pm 5.51 |
| V | 25 \pm 2.08 | 508 \pm 3.51 |
| SEd | 2.80079 | |
| CD ($p<0.05$) | 5.84237** | |

Values are mean \pm SD of three values in each column

** - Significant at 1% level ($P<0.01$)

Table 2. pH and NPK analysis of compost media

| Trails | pH | Available 'N' | Available 'P' | Available 'K' |
|-----------------|----------------------|------------------|-----------------|-----------------|
| I | 7.53 \pm 0.40 | 336 \pm 3.51 | 992 \pm 2.52 | 1900 \pm 3.51 |
| II | 7.2 \pm 0.30 | 378 \pm 4.51 | 621 \pm 2.52 | 1840 \pm 3.00 |
| III | 7.34 \pm 0.35 | 406 \pm 3.00 | 678 \pm 3.00 | 1700 \pm 3.51 |
| IV | 7.2 \pm 0.30 | 411.6 \pm 5.01 | 896 \pm 2.52 | 1670 \pm 3.51 |
| V | 7.3 \pm 0.35 | 372 \pm 4.51 | 1011 \pm 2.52 | 1570 \pm 3.51 |
| SEd | 0.2802 | 3.4082 | 2.1396 | 2.7889 |
| CD ($P<0.05$) | 0.6243 ^{ns} | 7.5940** | 4.7673 ** | 6.2140** |

Mean \pm SEM. The mean in a column followed by the same letter (s) are not significantly ($P>0.05$) different according to Duncan's Multiple Range Test. ** Significant at $P<0.05$ respectively; ns – non significant

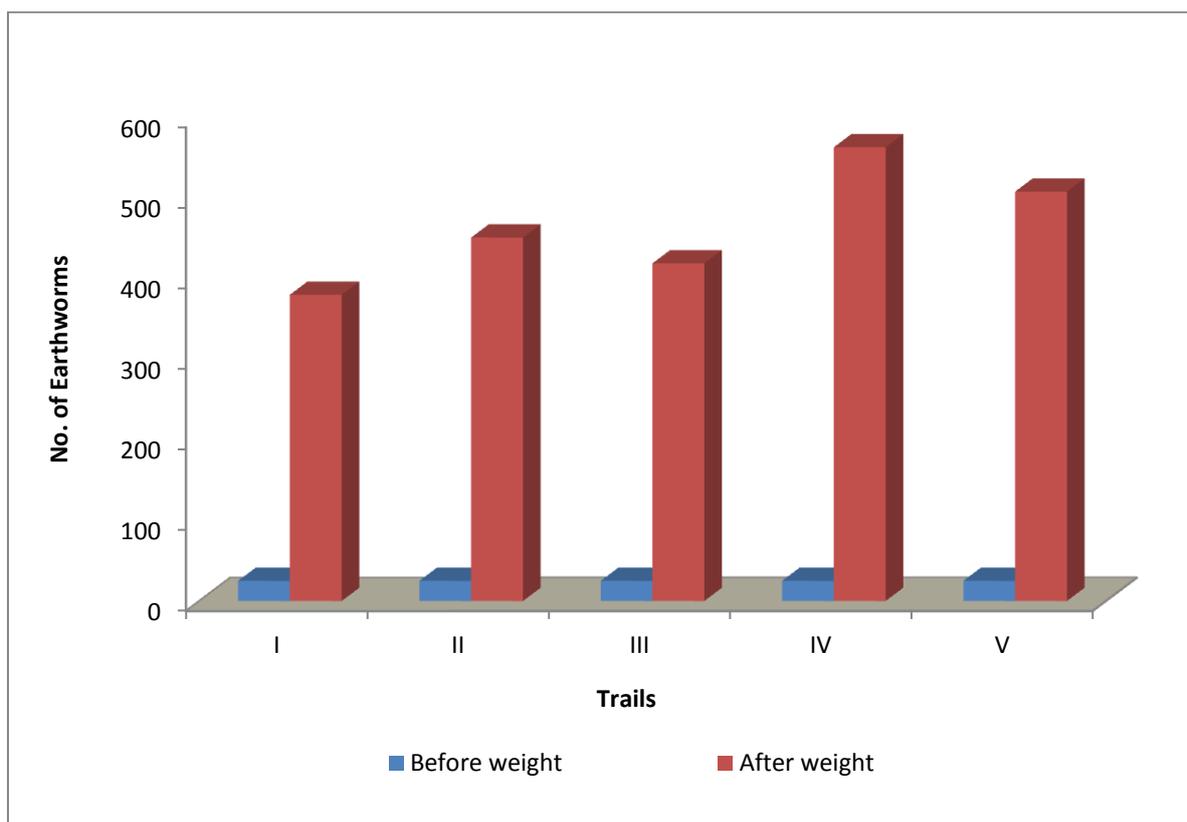


Fig. 1. Reproduction rate of different compost trails

3.5 Quality and Quantity of Organic Manure

The quality of the compost determines the fertility rate of the soil. The weight method is used to calculate the quantity of the compost. Vermicomposting is the conversion of organic waste through the synergistic actions of epigeic earthworms and bacteria. Co-composting with cattle dung helped to improve their acceptability for *E. fetida* and also improved their physico-chemical characteristics. The highest survival, maximum weight, and population build-up of *E. fetida* were determined by observing growth rate, weight, mortality, cocoon production rate, and population build-up.

4. DISCUSSION

Pre-composting of organic waste [14]; [15] for ten days was done by mixing the organic material with cattle manure. This process partially digests the material and avoids the thermophilic stage. Pre-composting is a process to sanitize and reduce the production of heat during the decomposition process. The experimental sample is an unused face mask made of

polypropylene. It also consists micro-plastics. Before experimental work, the mask bits are mixed with VAM and allowed to decompose for 15 days. This helps to avoid overheating in the vermicomposting system. For simple composting, the unused face mask is allowed 15 days to decompose. The weight gain was followed by weight loss by the time of the study's completion. The weight loss might be associated with the depletion of food [16] and [17]. Jesikha and [18] reported a related pattern of weight loss when earthworms attained sexual maturity because earthworms utilize the energy for reproduction purposes such as copulation, cocoon formation, and egg laying. Earthworm's bio accumulates toxic organic residues into their tissue, feeding on organic waste material.

Master of Variable is called Soil pH, it is the third and last component of healthy soil, and affects the availability of nutrients and minerals in the soil, as well as how well a plant can access, absorb, and regulate these materials. A very high or very low soil pH will result in nutrient deficiency or toxicity, leading to poor plant growth. A pH ranging from 6.0 to 7.0 is ideal for most garden vegetables. The soil test

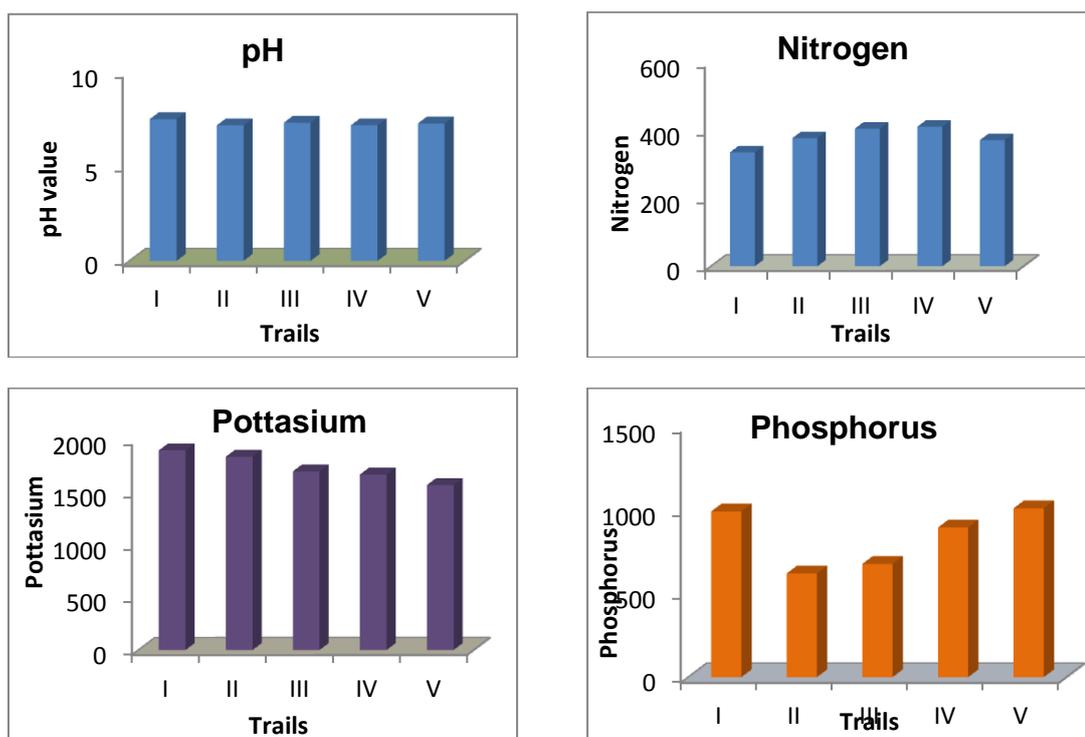


Fig. 2. pH and NPK analysis of compost media

results will make recommendations to adjust the soil pH. If your soil pH is too low (acidic), add garden lime to the bed. If your soil pH is too high (alkaline), add powdered sulphur to the soil. A soil conditioner that helps soil retains water. Nitrogen (N) promotes strong leaf and stem growth and a dark green colour. Phosphorus (P) promotes root and early plant growth. Potassium (K) promotes plant root vigour, disease and stress resistance, and enhances flavour. The optimum moisture content is between 50 and 60%. Higher moisture content may be required for composting straw and strong fibrous material. The nutrient balance is expressed as a carbon-to-nitrogen ratio (C/N ratio). Moisture is essential for composting, and rice wash water is used to maintain it. Temperature is a critical parameter, and the pH changes several times during composting. The quality of compost determines the fertility rate of the soil. Moisture content should be low to prevent anaerobic conditions, and a soil test will tell you the fertility of the soil. Compost should be black, crumbly, pH neutral, not dry, and contain more than one percent nitrogen, phosphate, and potassium (NPK).

5. CONCLUSION

Eisenia fetida's growth and reproduction depend on the availability of food sources. The dried leaf

of *L. speciosa* is the best source due to its high volume of NPK and good growth and reproductive rates. Other parameters such as temperature, moisture, pH, and C/N ratio also play a role. This study found that using earthworms to promote soil amelioration can significantly improve soil quality and fertility by accelerating the decomposition process and enhancing nutrient availability. The T4 and T5 produce the anti-pathogenic compost because the experimental plant *L. speciosa* has anti-viral, anti-bacterial properties. The findings have implications for sustainable agriculture and environmental management practices.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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