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# Effect of Native Microorganism of degraded Coconut rind and Wood for Quick Composting of Small Millets Crop Residues under Heap Method

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**ABSTRACT**

An experiment was conducted to evaluate the effect native microorganism from degraded coconut rind and wood for quick composting of small millets crop residues under heap method and also observed the physiochemical and biological changes that occurred during the composting process of finger millets, pearl millet, maize little millet, kodomillet, proso millet crop residues. In this study, the isolated native microorganisms from the collected degraded wood and coconut samples *(Pseudomonas* spp. *Bacillus spp, Aspergillus spp, Trichoderma spp, Phanerochetea spp.* were evaluated with existing TNAU Biomineralizer for composting of finger millet, pearl millet, maize, samai, varagu, panivaragu straws under heap method. The result indicated that the characteristics like color and moisture content of the obtained compost was under the quality standard after 90 days of composting period. The microbes like *Pseudomonas* spp. *Bacillus spp, Aspergillus spp, Trichoderma spp, Phanerochetea spp*. inoculated small millets residues compost shown the result of Moisture content of the 59.17 %, pH of 7.17, EC of 0.04 dSm-1, organic content of 25.45 % with 0.81 % of Nitrogen , 0.77 % of Phosphorus, 2.62% of Potassium with increased bacterial, fungal and actinomycets population due to effective composting process by application of native isolated microorganisms from lignin containing coconut rind and wood wastes materials . The quality compost was obtained after 90 days of composting period; the result was on par with TNAU biomineralizer. The total organic carbon content was 17:1 ratio, which was reduced due to composting by the isolated native microbes inoculated treatments and also in TNAU biomineralizer treatment whereas the C N ratio was 32:1 in control (without microbial application)

**Key words:** small millets, crop residues, isolated microorganisms, composting, organic manure

## INTRODUCTION

Composting is microbial process during favorable environment factors like air, temperature, relative humidity, microbial load, moisture content etc. favourable factors. During this process, decomposition of chemical constituents like cellulose, hemicellulose and lignin are converted into organic matter. The crop composting involved with physical, chemical and biological changes to microbes for their food needs and releases heat, water and $CO_2$ (Gajalakshmi and Abbasi, 2008) produce final organic matter. The organic substances viz., sugar, cellulose, carbohydrates etc., are attacked by

Compost is a organic fertilizer, which incrases the soil biodiversity. Compost application is very importante practice to be followed for soil fertility management **(**Scotti *et al*., 2016). The important technique in composting involves a biological process carried out by microorganisms. During composting, the biomass complex compounds converted into simple compunds by oxidative and enzymatic hydrolysis processes characterized by different phases like mesophilic, thermophilic, cooling, and maturation occurs. The final compost product contains humus and other nutrients.

Microorganisms in composting regúlate the soil nutrient buildup process (Aguilar-Paredes et al., 2010) and involving in organic matter decomposition which regulates soil physio- chemical and biological properties, heavy metal and other pollutants degradation, and reduction of greenhouse gases. The microbial communities contributes the sustainable and environmental friendly agriculture, which is important to enhance soil fertility (Yang et al., 2017 and Ma et al., 2020).The composting process depends on type of microorganims, C/N ratio of the materials and environmental factors like temperature, moisture content etc., are directly involves in the multiplication of different microorganisms (Karadag et al., 2013 and Wang et al., 2018). The biogeochemical degradation is a microbial composting process for degradation of hemicellulose during thermophilic phase (Li et al., 2019 and Wang et al., 2016).

The importan bacteria in the composting process are *Proteobacteria, Firmicutes, Actinobacteria,Bacteroidetes Proteobacteria Chloroflexi* are involved in the mineralization of nitrogenous organic substrate; complex carbohydrates of lignocellulose , cellulose, hemicellulose during composting process (Make et al.,2021; Zhao et al.,2016 and Quinn et al.,2020). The genera bacteria viz., *Bacillus*, *Brevibacillus*, *Aeribacillus*, *Geobacillus* play an important role in degradation of lignocellulolose and cellulose because of proteases and pectinases enzymes of the organisms (Xu et al., 2017 and Yin et al., 2017). The microorganims viz., *Pseudoclostridium*, *Caldibacillus*, and *Thermohydrogenium* produces endoglucanases and exoglucannases for composting of the waste materials.

The species of actinobacteria are thermotolerant like *Micromonospora*. *Thermoactinomyces*, *Thermomonospora* and *Actinobifida* are spread its hyphae like threads on the surface of compost and throughout the composite at the widest range of temperatures up to the long maturation stage of compost (Kausar et al., 2010 and Insam and de Bertoldi, 2007).Proteobacteria are gram- negative like Stenotrophomonas, *Halotalea*, *Myxobacteria*, *Pseudomonas*, and *Acinetobacter* were active in mesophilic stage of composting through segretion of lipopolysaccharide containing substances (Kersters et al., 2006 ;Rizzatti et al.,2017).

The beneficial microorganisms can be isolated from different sources like decomposed materials and soil, which can be cultured and screened according to their decomposting ability and then used as inoculums for composting (Rastogi et al., 2020). Composting agents can comprise a single microbial strain (Huang et al., 2017), a mixture of strains (Nagasagi and Hirai ,2017), or mature compost (Wang et al., 2015). The optimal temperature range for different phases of composting varies 50–65 ˚C for a minimum of 5–3 days to allow sanitization for maturation to produce quality compost. The pH range of 7.5–8.5 is essential for decomposting of organic substances by microorganisms during composting. A pH range of 7.5–8.5 essential for decomposition of organic matter by microorganisms during composting (Yu et al., 2019: Zhang and Sun, 2016).

During composting, microorganisms have the ability to break down the organic compounds into energy for metabolism and absorb the nutrients for the growth. Carbon and nitrogen are essential for energy and build of microbial cell structure. An optimal C/N ratio is essential for microbial activities in the composting process and the Carbon Nitrogen ratio accelerates organic compounds for degradation. The optimum Carbon to Nitrogen ratio required for composting is 30:1 (Macias-Corral, 2019). Carbon is needed as the energy source for the microorganism and nitrogen for the amino acid, nucleic acid, and protein synthesis. In our study, we maintain the C/N ratio of 30:1 in all four piles so that the process gets a quick acceleration. The moisture is very essential for the transport of nutrient within the cell wall of microorganisms during composting. This can be maintained through adequate water spraying. The average moisture content of 40-60% needed for composting (Kim et al., 2015). Temperature for composting is a critical parameter for the process of active microbial growth. The average temperature required for composting is 40-60$^{o}$C (Chinakwe., 2019)

The quality of the compost depends on the content of macronutrient viz., Nitrogen, Phosphorus, and Potassium (Edwards et al 2000).The nutrient content of the compost is very essential for plant growth and development. The standard for the compost quality is matched with the Indian Fertilizer Control Order-1985. The use of the compost also depends on time required to produce mature and nutritious compost. Composting is microbial environmental oriented process. In this process, the wastes based on organic sources like coffee pulp compost converted into organic manure (Krishnaveni et al, 2021). The harmful effects of sugarcane trash burning and significant benefit on utilization of sugarcane trashes (Dhanushkodi et al., 2022). Effect of different decomposer application in shredded trashes and raw trashes composting and its influence on soil nutrients and productivity of sugarcane were studied (Dhanushkodi et al., 2023).

**MATERIALS AND METHODS**

The small millets crop viz., ragi, cumbu, maize, samai, varagu, panivaragu straws were used as composting substrates. The crop residues were shade dried composting processes. All the small millets crop residues were accumulated with equal ratios according to the treatments viz., T1 - finger millets, pearl millet, maize, little millet, kodomillet, proso millet straws + isolated INMo –W ( Isolated native microorganism of decayed wood),,T2 - finger millets, pearl millet, maize little millet, kodomillet, proso millet straws + INMo –CR (Isolated native microorganism of decayed coconut rind (INMo – CR),, T3 - ragi, cumbu, maize samai, varagu panivaragu straws + TNAU biomineralizer,T4- ragi, cumbu, maize samai, varagu panivaragu straws + *Pleurotus* *sojar caju ,*T5 – *Control ( without microbial culture)* .Each crop residues were heaped (3 X 3 X 6 feet height, width and length) sprinkled with water. Inoculation of different screened bacteria and fungus were used as different treatments. Dosage of the microbial inoculum was based on the standard dose of 2 kg of microbial inoculum per ton of waste. Sixty days after inoculation of microbial isolates, the treatments were subjected to physio – chemical and biological parameters analysis.

The colour was observed throughout the composting period. The moisture content of different crop waste composts was measured using a Moisture Content Meter. The pH of the small millets crop waste was measured by pH meter after processing the samples in the laboratory. The EC content was measured through mixing 10 gram of compost in 25 ml of water and the determined by Electrical Conductivity Meter after 30 min and unit as dS/m. The organic carbon (OC) the samples was estimated by Walkley and Black method. Nitrogen content was determined using the digestion method. Phosphorus by Spectrophotometer and Potassium by Flame photometer and expressed the unit in Percentage. For the estimation of microorganisms, the growth media like nutrient agar, rose Bengal agar and ken knight were prepared and sterilized in the autoclave at 120 $^{o}$ C at 15 psi. The one gram of small millets compost samples was serially diluted and poured into different Petri plates and then incubated in the incubator at 24 $^{o}$C (serial dilution and plating technique). The well developed and predominant colonies in the petri plates were observed and counted and expressed based on dilution factors. All the experiments were conducted using completely randomized design (CRD) with four replications. Results were subjected to analysis of variance (ANOVA) and tested for significance by Least Significance Different (LSD).

## RESULTS AND DISCUSSION

In this study, the information is that the effectiveness of the isolated microorganism like *Pseudomonas* spp., *Bacillus* spp., *Phanerochaete* spp., *Trichoderma* spp., and *Aspergilllus* spp., were were evaluated with existing TNAU Biomineralizer for the composting of ragi, cumbu, maize samai, varagu panivaragu straws. The result indicated that the physical, chemical and biological properties like colour, moisture content, N, P, K content, total organic carbon, C/N ratio was increased with composting period of 90 days. The nutrient status of the crop wastes was increased due to composting by the isolated microorganisms, which is on par with TNAU biomineralizer and result presented inTable-1.

**Table : 1- Physical, chemical and biological characteristics of different crop residues compost in heap method (Mean of 5 replications)**

| Treatments | Colour | Moisture (%) | pH | EC (d S m-1) | TOC (%) | N (%) | P (%) | K (%) | C/N ratio | Bacteria x $10^{6}$ - cfu | Fungi x $10^{4}$ - cfu | Actinomycetes x 10 -3 cfu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | Black | 59.17 | 7.17 | 0.04 | 25.45 | **0.81** | **0.77** | **2.62** | 17:1 | 28.74 | 16.67 | 11.56 |
| $T_2$ | Black | 59.15 | 7.25 | 0.06 | 25.18 | 0.73 | 0.64 | 2.43 | 19:1 | 28.65 | 16.34 | 11.45 |
| $T_3$ | Black | 58.98 | 7.15 | 0.08 | 24.34 | 0.68 | 0.63 | 2.18 | 20:1 | 24.15 | 15.23 | 9.34 |
| $T_4$ | Black | 57.67 | 7.12 | 0.09 | 23.16 | 0.54 | 0.39 | 2.21 | 25:1 | 19.23 | 14.32 | 7.25 |
| $T_5$ | Brown | 46.87 | 7.89 | 0.17 | 15.15 | 0.35 | 0.24 | 1.18 | 32:1 | 15.34 | 11.32 | 6.45 |
| SEd | - | 0.044 | 0.05 | 0.23 | 0.05 | 0.041 | 0.034 | 0.12 | 0.321 | 0.468 | 0.129 | 0.121 |
| CD (P=0.05) | - | NS | NS | NS | 0.088 | O.18 | 0.063 | 0.23 | 0.543 | 0.876 | 0.321 | 0.265 |

T1 - finger millets, pearl millet, maize, little millet, kodomillet, proso millet straws + isolated INMo -W,T2 - finger millets, pearl millet, maize little millet, kodomillet, proso millet straws + INMo –CR, T3 - ragi, cumbu, maize samai, varagu panivaragu straws + TNAU biomineralizer,T4- ragi, cumbu, maize samai, varagu panivaragu straws + *Pleurotus sojar caju* ,T5 – *Control ( without microbial culture)* ,Native screened microbial formulations (NSMF), Isolated native microorganism of decayed wood (INMo – W),Isolated native microorganism of decayed coconut rind (INMo – CR), NS: Non-Significant

The colour of the compost was slightly changing from brown to dark brown and then black. The change in moisture content was found to be not significantly different among the treatments. However, the moisture content of the two treatments *Viz.*, T1 - finger millets, pearl millet, maize, little millet, kodomillet, proso millet straws + isolated INMo –W ( Isolated native microorganism of decayed wood) and T2 - finger millets, pearl millet, maize little millet, kodomillet, proso millet straws + INMo –CR (Isolated native microorganism of decayed coconut rind (INMo – CR) and T3 - ragi, cumbu, maize samai, varagu panivaragu straws + TNAU biomineralizer were found to be optimum due to proper composting process. The slight variations in moisture were found in $T_4$ and $T_5$ (Control) , which is related with the microbial population and nature of microorganisms, which are maintained essential for moisture content of the compost. The change in pH of the different treatments was found to be not significant. However, the highest pH was found in $T_5$ (without microbial inoculation). The changes in pH were found to be significant in $T_1$ to $T_4$ related with the type of microorganism involved in the composting process.

The electrical conductivity (EC) value of the different composts was found to significant in $T_1$, - $T_4$ treatments So, the compost is suitable for plant growth and development whereas the EC value was comparatively higher in $T_5$ (0.23 dS/m). The compost obtained by isolated microbial culture was found to be the optimum moisture content ($T_1$) with 59.17 per cent than uninoculated microbial culture treatment of 46.87 per cent. Generally, any compost has 60 per cent compost is good for microbial activities. At the end of composting period, the nutrient quality viz., nitrogen, phosphorus, and potassium (NPK) vary in compost prepared from different organic sources. The quality measurement of composts was taken based on macronutrients like nitrogen, phosphorus, and potassium. Comparing the composts show that te treatment T1 and T2 shown more amount of nitrogen, phosphorus and potassium and shown in the table -1

In this study, the compost varied in all measured physical, chemical and biological traits. The microbes like *Pseudomonas* spp. *Bacillus spp, Aspergillus spp, Trichoderma spp, Phanerochetea spp*. inoculated small millets residues compost shown the result of Moisture content of the 59.17 %, pH of 7.17, EC of 0.04 dSm-1, organic content of 25.45 % with 0.81 % of Nitrogen , 0.77 % of Phosphorus, 2.62% of Potassium with increased bacterial, fungal and actinomycets population due to effective composting process by application of native isolated microorganisms from lignin containing coconut rind and wood wastes materials. The isolated microorganisms can be utilized for potentially convert the waste into value added products in a short duration. The compost obtained by different microbial cultures used for decomposition of small millets crop residues showed the highest nitrogen (N),phosphorus (P) and potassium (K) as compared to without microbial treatment. The amount of macronutrients present in the compost based on the standard value. The amounts of macronutrients were higher than the initial period. The changes in C/N ratio for all treatments during the composting presented in Table 1. The result showed the C: N ratio was obtained from $T_1$ and $T_2$. During the composting process, the value of C: N ratio between 24 to 27 because of the dryness of the materials (Nasagi et al., 2017) in all the com-post whereas the, C: N ratio of 29.83 during the initial process and decrease to the level of 17.21 in $T_1$ at the end of composting process . The microbial population viz., Bacteria, Fungi and Actinomycetes were presented in the Table -1

In the experiment the organic carbon content of the compost was reduced in the microorganisms inoculated treatments, The reduction of organic carbon content during the composting process was also reported by Chabbey, 1993. The bacteria population was found to be increased after the initiation of composting. The population of bacteria in different compost has shown a significant difference. However, the compost obtained from native isolated microorganisms and TNAU biomineralizer have shown highest microbial population. In contrast, the number of actinomycetes was found to be common in all the treatments. This substrate provides the sources of bacteria that fasten the decomposition process. The compost contains macronutrients like N, P and K and also improves the electrical conductivity, water holding capacity and moisture content of the compost.

The population of microorganisms increase during the composting process in all the treatments. The maximum growth of bacteria and fungi observed in $T_1$ –$T_3$ due to more number microorganisms utilized as organic sources for the growth and multiplication, which was similar the report ( Flack and Hartenstein, 1984) obtained similar results in regard to Azotobacter on earthworms. Many findings indicated that the microorganisms utilize in their substrates as a food source (Edwards et al., 2000).

## CONCLUSION

The small millets crops viz., finger millets, pearl millet, maize little millet, kodomillet, proso millet straws inoculated of different screened bacteria and fungus were used as different treatments. Dosage of the microbial inoculum was confirmed based on the standard dose of 2 kg of microbial inoculum per ton of waste. The physical and chemical analysis of the compost produced by different microbial culture has shown the optimum variations in moisture, pH, EC and significant increase in the Nitrogen, Phosphorus, Potassium and microbial populations like bacteria, fungi and actinomycetes due to inoculation of microbes like *Pseudomonas* spp. *Bacillus spp, Aspergillus spp, Trichoderma spp, Phanerochetea spp*. inoculated in the small millets residues with duration of 90 days. The compost produced especially the native microbial culture inoculated contains optimum quality parameters which is suitable for crop cultivation. The native based microbial degradation of small millets wastes reduces composting period of around 30 to 40 days in addition to quality compost,.The isolated native microorganisms from the collected degraded wood and coconut samples *(Pseudomonas* spp. *Bacillus spp, Aspergillus spp, Trichoderma spp, Phanerochetea spp.* were mass multiplied to distribute as a commercial formulation either in liquid or solid formulations for composting all small millet crop residues.

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