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An Eco-Biological Approach for Resource Recycling and Pathogen (*Rhizoctoniae Solani* Kuhn.) Suppression

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Abstract

Composting of coffee husk, coir pith and cow manure is carried out in bags with *Trichoderma viride* as inoculant. Vermiconversion of these is achieved by top load mechanism in a vermireactor using *Eudrilus eugeniae*. Both vermicompost and compost have aided in neutralizing the high acidic (pH-5.7-6.5) content of pure coffee husk and cow manure. Among the available nutrients, nitrogen content in composted end products of cow manure was 195 mg/kg, in coir pith 193.88mg/kg and in coffee husk it was 240.47mg/kg and in vermicomposted end products of cow manure it was 165.6 mg/kg, in coir pith it was 240mg/kg and in coffee husk it was 248.10mg/kg. Available phosphate in cow manure was 180.5mg/kg, in coir pith it was 157.14mg/kg and in coffee husk it was 275.52mg/kg of the composted end products and in vermicomposted end products of cow manure it was 190.4mg/kg, in coir pith it was 120.96mg/kg and in coffee husk it was 185mg/kg. Similarly available potassium was 255mg/kg, 263.37mg/kg and 317.04mg/kg respectively in composted end products of cow manure, coir pith and coffee husk and in vermicomposted end products it was 129mg/kg, 421.6mg/kg and 89.9mg/kg respectively. Nitrogen content was relatively high (248.10 mg/kg) in coffee husk vermicompost, available phosphate content was high (275.52 mg/kg) in coffee husk compost and available potassium was higher (421.6 mg/kg) in coir pith vermicompost. Extracts of composted and vermicomposted coffee husk, coir pith and cow manure were evaluated individually for suppression of pathogen *Rhizoctonia solani.* Pathogen suppressive property against *R.solani* was observed at 12hr, 24hr, 48hr and 72hr intervals. The percentage of growth inhibition was higher (60.55%) after 72hrs in the media amended with the extracts of coir pith vermicompost (CPVC) followed by extract of coffee husk vermicompost (CHVC)(46.11%). Pathogen suppression by cow manure vermicompost (CMVC) though initially was 16.18% at 48hrs, it was not retained and by the end of 72 hrs full development of the pathogen was observed in both the CMVC and that of control which consisted of media amended with only water. However inhibition by the composted end products of coir pith was relatively less (40.85%) as well as that of cow manure (15.54%) and coffee husk (50.85%) by 24 hrs. The ability to suppress the growth of *R.solani* by coir pith vermicasts can be attributed partly to higher potassium content, which helps in the absorption of plant nutrients as well as the high nutrients (nitrogen and phosphates) available leading to growth promotion and thereby disease resistance. Neutral pH of the soil also aids in the adequate absorption of nutrients. This paper presents a new approach in the characterization of physicochemical properties of the recycled products and their pathogen suppressive effect.

Keywords: Coir pith, Coffee husk, Compost, Vermicompost, *Rhizoctonia solani.*

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Introduction

Coir pith (CP)(1) and coffee husk(CH)(2) are suitable for compost and vermicompost. Though CP contains higher proportions of cellulose besides potash and lignin, it has excellent moisture retaining capacity but is slow in decomposition (3). CH contains caffeine, polyphenols, tannins, clorogenic, ferulic and coffee acids (4). The high bacterial growth in the earthworm intestines (5) improves soil fertility and stimulates plant growth (6) making vermicasts as good organic manure and potting media (7). Vermicompost used as container media reduced the infection of tomato plant by *Phytophthora nicotianae* Breda de Haan var. *nicotianae* (8). A mixture of clay and vermicompost increased plant growth and yield (9).

The African night crawler, *Eudrilus eugeniae* (Kinberg), relatively a large worm has a faster growth rate, being prolific feeder resulting in not only faster rate of vermicomposting, but also as an ideal animal protein feed (10). Compost improves soil structure increasing soil organic matter, suppresses soil borne plant pathogens and enhances plant growth (11) and the disease suppressive

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property depends on the maturity of the compost. Compost controls disease of tomato plant and reduces economic losses (12). *Trichoderma* sp, was used as an inoculant for composting of sorghum stalk, wheat straw, leaves of *Eugenia jambolana* and paddy straw (13). Composted cow manure could suppress dollar spot (*Sacetrotinia homeocarpa*) of turf grass (12) and also *Phythium* (damping – off) and *Verticillum* (wilt) (14).

This paper besides evaluating the nutrient status of both composted and vermicomposted coir pith, coffee husk and cow manure also evaluates its pathogen suppressive property. The enhanced nutrient status is demonstrated in suppressing the growth of plant pathogen *R.solani* in invitro studies. Results of the experiments point to the two-way advantage of utilizing the cost-effective technology in recycling agro industrial wastes (CP and CH), improve soil fertility for better plant growth, resistance and the suppressive effect on *R.solani* Kuhn.

Material and Methods

Vermicomposting of coir pith, coffee husk and cow manure was done in 3 ltr. containers using *Eudrilus eugeniae* by top load mechanism (15) using CM, CP and CH as feed. Microbial compost was done in nylon bags on 90 days duration. All experiments were run in duplicates. Physico-chemical characteristics of the compost and vermicompost from the respective reactors were analysed following standard methods (16). For composting the inoculant *Trichoderma viride* was cultured in broth (17) and the plant pathogen *R.solani* was cultured in PDA in a Petridish (18). Media were mixed with 20% water extracts of both composted (COM) and vermicomposted (VC) coir pith, coffee husk and cow manure and for control only water was used. Radial growth of the pathogen was measured and percentage of inhibition calculated (19) for 12 hrs, 24 hrs, 48 hrs and 72 hrs.

Results and Discussion

Figure 1 presents select physico chemical characteristics of CM, CP and CH as well as the composted and vermicomposted CM, CP and CH.

Figure 1. Physico chemical characteristics of the compost and vermicompost samples of cowmanure, coirpith and coffee husk.

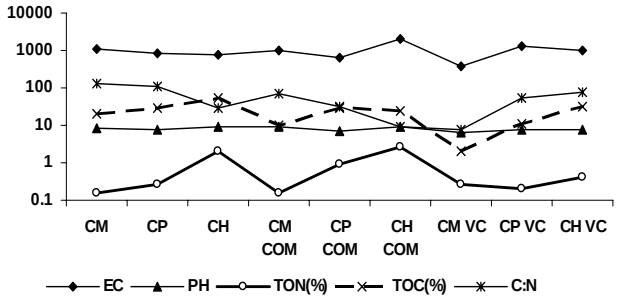
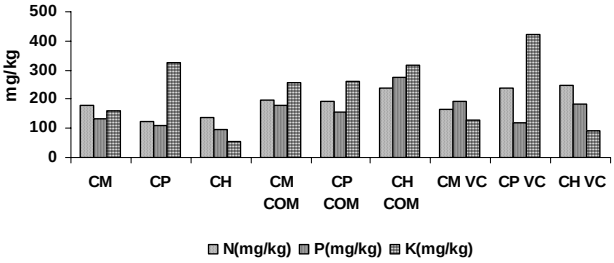


Figure 2 presents available nitrogen, phosphate and potash content in the same nine samples. Carbon and nitrogen ratio projects the digestion rate of the organic waste by earthworm (20), by microorganism (21) and it is observed that the ratio of C:N obtained in composted (12) and vermicomposted products of CP and CH (23,24) is more favorable for the plant pathogen suppressive effect. Vermicompost applied to soil enhances available macronutrients as well as the microbial populations (25).

Figure 2. Available NPK content in the composted and vermicomposted samples of cowmanure, coirpith and coffee husk.



pH was in the range of 9.5 to 6.3 - in composted CM (8.9),CP (7.0),CH(9.5) and in vermicomposted CM (6.3),CP (7.5),CH (7.2). Composting influences temperature, pH and microbial succession (24). The near neutral pH in composted CP and vermicomposted CH is beneficial for plant growth (9). pH variation depends on factors like temperature, moisture and aeration (24). There is a slight increase in EC in CHCOM followed by CPVC and CHVC. Increase in EC indicates a successful composting process (11).

Available nitrogen content in composted CM (195mg/kg),CP (193.88mg/kg) CH (240.47mg/kg) on comparison with that in vermicomposted CM (165.6mg/kg), CP (240mg/kg) and CH (248.10mg/kg) indicates that the available nitrogen is higher in vermicast of coffee husk, followed by composted coffee husk.

Available phosphate content was 180.5mg/kg in CM; 157.14mg/kg in CP; 275.52mg/kg in CH composted end products and in vermicomposted it was CM (190.4mg/kg),CP (120.96mg/kg),CH (185mg/kg). It is observed that composting has enhanced phosphate content in coffee husk in comparison with the same in untreated (96.25mg/kg). Available potassium content was in CM (255mg/kg),CP (263.37mg/kg), CH (317.04mg/kg) in composted and CM (129mg/kg),CP (421.6mg/kg),CH (89.9mg/kg) in vermicomposted.

Potassium content was relatively enhanced (421.6gm/kg) in coir pith after vermitreatment from the initial content (324.7mg/kg) in untreated coir pith. Higher potassium helps for better absorption of plant nutrients, aids for faster germination and better plant growth (21). Vermicompost when incorporated into container media or

soil it improves their physical, chemical and microbial properties and stimulates plant growth (7).

Figure 3 and 4 indicate the percentage of radial growth of *R.solani* at 12 hrs, 24 hrs, 48 hrs, and 72 hrs. From these experiments it is observed that 65.71% inhibition of *R.solani* is achieved with CPVC extract by 12 hrs. By 24hrs 50.85% and 40.85% of inhibition is achieved in composted CH and CP respectively. In composted CM it was 15.54% which subsequently by 72hrs has reduced to 6.22%. In vermicomposted CM, CP and CH by 24 hrs the percentage of inhibition was 18.2; 38.2; and 32.7. However by 72 hrs the percentage of growth inhibition against *R. solani* with CMVC was reduced to 5.5% and it was 60.55% of inhibition with CPVC extract and with CHVC extract 46.11% of inhibition was achieved.

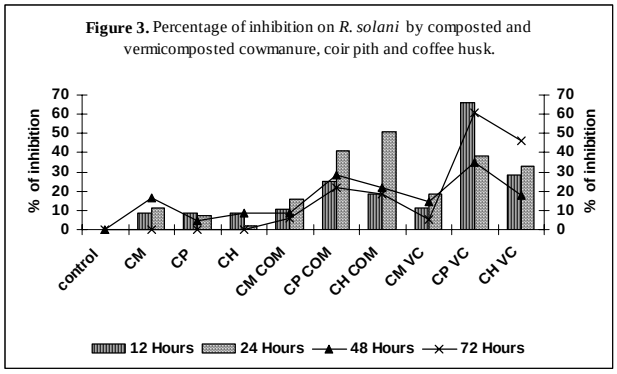


Figure 3. Percentage of inhibition on *R. solani* by composted and vermicomposted cowmanure, coir pith and coffee husk.

Addition of compost to soil can reduce diseases caused by soil borne fungi (14). Results of the present study indicate that the composted and vermicomposted coir pith and coffee husk contain the plant growth nutrients, which effectively suppressed growth of *R.solani* Kuhn. Potassium content being relatively higher the vermicomposted coir pith and composted coffee husk exhibited better suppression of *R.solani* by 12 hrs and 24 hrs respectively.

Conclusions

Cow manure, coir pith, coffee husk, composted and vermicomposted cow manure, coir pith and coffee husk were tested for the suppression of plant pathogen *R. solani* Kuhn. It is demonstrated that the composted and vermicomposted coir pith and coffee husk contribute for the over all improvement of soil fertility and thereby for a better resistance against the pathogen. Comoposting and vermicomposting is a cost effective technology which could be used at industrial level for recycling the industrial wastes. These recycled products enhance soil nutrients, provide better growth and resistance and they possess commercial appreciation.

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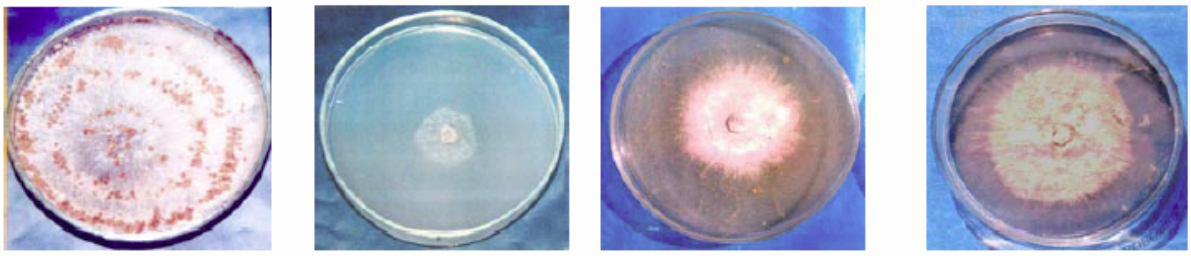
Figure 4. Suppressed growth of *R. solani*.



Control **CP VC 12Hours** **CP VC 72Hours** **CHCOM 24Hours**

CPVC= Vermicomposted Coir Pith CHCOM=Composted Coffee Husk

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