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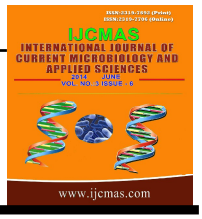

Original Research Article

Assessment of Sawdust as Carrier Material for Fungal Inoculum Intended For Faster Composting

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Sawdust, carrier material, starter cultures, composting, *Chaetomium*

A B S T R A C T

Present day composting technologies effectively employ efficient microorganisms for cutting short the lengthy durations typical of the age old conventional processes. Several superior cellulolytic fungal organisms are known to substantially hasten biodegradation but are significant by their absence in the large-scale commercial composting scenario. Obvious difficulties arising in packaging, transportation and handling of such cultures housed in laboratory glass containers might explain the limited usage of efficient fungal isolates in composting. Development of starter cultures of proven efficient cellulolytic microorganisms for composting, based on compatible easily available carrier materials is seemingly a practicable solution to overcome these difficulties. This communication deals with effective utilization of forest industry waste viz. sawdust, as carrier material for starter culture formulations of superior cellulolytic fungal inoculum designed for rapid composting. Suitability of sawdust as carrier material, its compatibility with efficient fungal inoculum, usage of the carrier material based starter cultures in composting and shelf life of sawdust carrier based culture formulations is discussed. Sawdust obtained from forest saw mills was evaluated and found suitable as an environment- and user-friendly carrier material for fungal inoculum intended for speedy composting.

Introduction

The recent past has demonstrated several instances of inclination towards sustainability. Popularity of sustainable agriculture has picked up. Recycling of organic wastes, a traditionally beneficial concept, which had been largely neglected in near recent times, has come to the fore front and gained approval. Today, as the world struggles against formidable challenges put forth by the massive quantities of wastes generated, composting has been successfully advocated as an effective, safe and reasonably inexpensive solution for dealing with solid organic wastes (Rawat *et al.*, 2013). Besides providing much needed nutrients and organic matter to soil, the practice ensures hygienic disposal of the wastes.

Modern research in composting is aimed at reducing the typically lengthy periods associated with the traditional techniques and simultaneously enhancing the quality of the product; through effective utilization of active decomposer microorganisms and incorporation of amendments (Torkashvand, 2010; Gautam *et al*., 2011). While cellulose degrading fungi as well as bacteria can carry out biodegradation, the fungi, owing to their distinctive habit, apparently have an upper edge.

Several superior fungal isolates are known to carry out effective biodegradation. However popularizing of efficient fungal inoculum for wide-spread usage in composting has encountered problems such as safe packaging and transportation of the laboratory-based fungal cultures to the end users lacking expertise in skillful handling of such cultures. Efficient fungal starter inoculants, grown and stored in conventional laboratory glassware, need innovative packaging ensuring safe transportation and usage. The concept of carriers was envisioned with respect to bacterial inoculants (Subba Rao, 1984) and several carrier materials were identified (Smith, 1992).

Carrier based starter culture formulations of effective composting microorganisms are generally based on food grains (Rasal and Patil, 2001). Scanty literature exists on novel carrier materials for starter cultures of cellulolytic fungal organisms for composting and there is abundant scope for promotion of many more, superior and cost-effective materials for use as carriers. In the present investigation sawdust from forest saw mills was assessed for suitability as a user-friendly carrier material for starter cultures of efficient cellulolytic fungal inoculum developed for faster composting of organic wastes.

Materials and Methods

The forest industry residue selected for assessment viz. sawdust of forest trees was obtained from saw mills situated in Chendani bunder area of Thane, on the western coast of Maharashtra in India. The sawdust, on procuring was heated to 80^0C for 4 hours as part of pre-treatment. Fifteen grams of pre-treated sawdust in separate glass bottles of 100 ml capacity each, was adjusted to 60% moisture (Mishra, 2002) with Reese liquid medium, and autoclaved at 20 lbs psi pressure for 1 hour; followed by inoculation with 2ml of spore suspension (10^6 spores/ ml) of the respective cellulolytic isolate. Five cellulolytic isolates, namely, *Chaetomium globosum* Kunze, *C.crispatum* Fuckel, *C.olivaceum* Cooke and Ellis, *C.nigricolor* Ames *and C.virginicum* Ames, isolated from a variety of deteriorated cellulosic materials (Kolet, 2009; 2010a) and evaluated for superior cellulose degradation capabilities (Kolet, 2010b,c) were used as test inoculum. Sterile distilled water was used instead of spore suspension in the control set. The bottles were capped and incubated at room temperature (28^0C) for a period of 15 days, during which, mycelial and ascomatal growths of the respective isolates on the carrier material were visually monitored and documented.

After this initial incubation period, the carrier based starter culture formulations were packaged in sealed polythene bags (Sethi and Adhikary, 2012), and stored at room temperature for 4 months. At the end of the storage period, 200 ascomata each, of the respective isolates, growing on the carrier material were plated out on PDA medium. Their ability to grow out successfully was documented and interpreted as viability of the carrier based starter culture inoculum.

The sawdust based starter cultures were used for laboratory scale indoor composting (Singh *et al*., 1992) of religious refuse (flower wastes after religious services and *pooja*). Individual starter culture based inoculum of the 5 isolates was mixed in equal proportions by weight and applied @ 100g starter culture/100kg raw material for rapid composting of the flower residues and the process of biodegradation was monitored for a period of 1 month.

Results and Discussion

Forest-, timber- and wood-based industries thrive in the district of Thane (Anon, 2001) and hence the forest industry residue selected for assessment, namely sawdust of forest trees was abundantly available in the area of study viz. the city of Thane situated on the western coast of India, in the state of Maharashtra. The impacts of rapid urbanization and population explosion are however evident and many forest based saw mills have shut down or relocated to semi-urban or rural locations in the vicinity. The characteristics of the pre-treated carrier material are depicted in Table 1. Sawdust as carrier material exhibited high organic matter and water holding capacity. The high C: N ratio apparently did not pose any hinderance to growth and multiplication of the cellulolytic inoculum. The selected carrier material fulfilled characteristics of a good carrier base; findings of which are in conformation with Malusa *et al*. (2012).

The cellulolytic fungal inoculum was further multiplied, maintained and stored in the carrier material after the initial incubation period. The pattern of initial 15 days development of the inoculum on the carrier material is depicted in Table 2. Carrier material comprising sawdust sustained excellent growth and multiplication of the cellulolytic fungal inoculum, which was interpreted as a sign of compatibility of the carrier material with the starter organisms. There was no lump formation in the carrier material throughout the period of study, indicating aeration and conditions favourable for growth.

The shelf life of the starter cultures was monitored after 4 months of storage. The fungal inoculum was maintained and multiplied in the carrier material during this period. Results presented in Table 3 reveal excellent viability of the inoculum after the period of storage. The findings agree with those of Abdel-Kader *et al*. (2012).

The application of starter cultures based on the carrier material at the rate of 100g starter culture/ 100kg raw material brought about faster composting of religious floral refuse and resulted in 75.35 per cent and 72.9 per cent reductions in volume and weight respectively, in the substrate, as against 43.26 per cent and 49.7 per cent reductions respectively in the control. The C: N ratio narrowed down to 16.06 from the initial 24.05 in the composting period of 1 month as against 21.40 in the control. The influence of the sawdust based starter inoculum on the process of composting is presented in Table 4. The results are in agreement with Gosavi and Bagool (2014).

Several materials have been appraised as carriers for microbial inoculants serving various purposes (Stella and Sivasakthivelan, 2009; Selvi, 2013). Arora *et al* (2008) successfully assessed sawdust as carrier material for bacterial inoculants.

Table.1 Characteristics of the Pre-treated Carrier Material (Sawdust)

Parameter	Characteristics
Colour	Brown
Texture	Powder
Particle size	Passed through 8 mesh size
Moisture (%)	10.2
Organic Matter (%)	71.11
Organic Carbon (%)	41.25
Nitrogen (%)	0.10
C:N Ratio	412.5 : 1
Water held by 10 g sample (ml)	9.5
Effective water holding capacity (%)	95

Table.2 Fifteen days growth of test organisms on the sawdust based carrier material

Test Organism	Pattern of growth		
	5D	10D	15D
Chaetomium globosum	++/+	+++/+++	+++/+++
C. crispatum	++/+	+++/+++	+++/+++
C. olivaceum	+/-	+++/+++	+++/+++
C. nigricolor	++/+	+++/+++	+++/+++
C. virginicum	++/+++	+++/+++	+++/+++

Mycelial development/ ascomatal development; '-': absence of growth, '+': *poor*, '++': moderate, '+++': rich growth

Table.3 Viability of sawdust based starter cultures after 4 months of storage

Test Organism	Percent viability (%)
Chaetomium globosum	87.4
C. crispatum	88.2
C. olivaceum	91.0
C. nigricolor	90.2
C. virginicum	94.8

Table.4 Influence of the carrier based starter culture inoculum on hastening the process of composting

Treatment/ Parameter	Compost sampling interval: 1 month					Reduction in		
	OC (%)	N (%)	C:N ratio	Volume (cm^3)	Weight (g)	OC (%)	volume (%)	weight (%)
Control	48.60	2.27	21.40	14595	2515	10.59	43.26	49.7
Raw material + starter culture	37.10	2.31	16.06	6340	1355	31.75	75.35	72.9

Substrate- Flower refuse; Initial values- OC: 54.36; N: 2.26; C:N ratio: 24.05; volume: 25725 cm^3; weight: 5kg

While fungal starter cultures of composting based on cereal grains are available (KKV, 2003), Gosavi and Bagool (2013) evaluated agro-wastes as carriers for similar purpose. Their plentiful availability, cost-effectivity, renewable and environment-friendly nature coupled with simple processes and minimal requirements for incorporation, confers advantages on agro- and other organic residues over conventional carrier materials. Their ligno-cellulosic nature makes them ideal substrates for mass production of cellulolytic inoculum for composting. While some amount of sawdust from forest based saw mills is put to use, a major quantity is wasted or burned. The commercial usage of sawdust as a carrier material for development of starter cultures of fungal inoculum for composting is anticipated.

A delivery system comprising starter cultures for composting was developed from a novel carrier material namely sawdust; tested and found effective. Apart from gainfully utilizing this ligno-cellulosic residue, the cost-effective starter cultures would be beneficial in the simplified distribution of efficient fungal inoculum for rapid composting. Sawdust was found suitable as carrier material for fungal starter cultures comprising of efficient cellulolytic strains developed for rapid composting.

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