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Aerobic Composting of Municipal Solid Waste Using Newly Developed Beneficial Microbial Consortium

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Abstract: This study was focused on aerobic composting of the municipal solid waste using the newly developed beneficial microbial consortium (BMC). Also the possibilities of using distillery spent wash as and moisturizing agent were also explored during the study. The obtained humus was characterized for various features such as its chemical composition and its possible effects on enhancement of plant growth. The results have shown that the aerobic composting process was completed efficiently in a shorter period of time (about 25 days). The obtained compost was found to be chemically balanced and biologically stable. It was found that the compost could efficiently be employed as a soil rejuvenator in agriculture. Also the spent wash was found to further enhance the qualities of the compost.

Key words: Municipal Solid Waste · Beneficial Microbial Consortium · Aerobic composting · Spent wash · Temperature

INTRODUCTION

Composting is a solid-waste fermentation process, which exploits the phenomenon of microbial degradation and mineralization [1]. Composting is basically a process of different organic solid wastes decomposition. The decomposition process is carried out by various microorganisms including bacteria and actinomycetes. This microbial activity results in formation of relatively stable organic compounds (humic substances) [2].

Different communities of microorganisms predominate during the various composting phases. Initial decomposition is carried by mesophilic microorganisms, which rapidly biodegrade the soluble and easily degradable compounds. The release of heat causes a rapid temperature rise. The temperature rises above 40°C, mesophilic mesophiles become less competitive and are replaced by thermophiles [3]. At temperatures exceeding 55°C many microorganisms including human and plant pathogens are destroyed in the MSW. Generally it was observed that for a rapid and efficient composting the temperatures must not be allowed to increase above 60°C. The thermophilic stage is attributed to the breakdown of complex high energy molecules in the solid waste, as soon as these high energy compounds are exhausted, the compost temperature gradually decreases and mesophilic microorganisms once again take over the other types of microorganisms during the maturation of the compost [4, 5].

The aim of the study was mainly focused on studying the possibilities of using BMC for a rapid composting of the MSW, additionally the possibilities of using the spent wash as a moisturizing agent were also explored. This will not only help in rapidly minimizing the environmental load of the MSW but also will be helpful in lowering the burden of spent wash disposal in to the environment. The BMC used for the study was developed using cultures of *Aspergillus niger*, *Thermomyces lanuginosus*, *Bacillus sphaericus* and *Bacillus subtilis*, which were obtained after a thorough study carried earlier. It was assumed that the BMC will be helpful in controlling the composting condition, reaching a stable and final compost in relatively shorter time.

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MATERIALS AND METHODS

Preparation of Windrows: The study was performed at the municipal solid waste dumping site at Naregaon, Aurangabad, using three windrows. The windrows were prepared using the same batch of MSW collected by municipal authorities, after proper removal of any non-degradable materials. The windrows prepared were 4x6x4 (width x length x height). All the windrows were run simultaneously at the same time.

- The first windrow (W_1) was constituted with the municipal solid waste and was left for natural decomposition.
- The second windrow (W_2) constituted of the similar municipal solid waste, but it was reinforced by addition of the previously prepared beneficial microbial consortium.
- The third windrow (W_3) was prepared similar to W_2, but during the process of composting it was moisturized with the distillery spent wash.

The BMC was added in the form of liquid culture in proportion of 1:10 (V/W) in each windrow. The process was carried out during winter when there was no rains. The moisture was provided as water and spent wash to W2 and W3 respectively, it started on the 5^{th} day and afterwards at a interval of 3 days. Temperature and humidity were recorded daily and controlled by turning the windrow and sprinkling the water to maintain enough moisture in it. The turning will also allow the provision for aeration of the compost. When the mean temperature recorded in different depths (20, 40 and 60 cm) of the pile averaged 55°C, the windrow was turned and moisturized with the desired source (water/spent wash). The temperature should not increase more than 90°C. The composting was carried for 21 days in an open location.

Physical and Chemical Parameters Determination: The finished and matured composts were subjected for various physical and chemical characterizations. These characterizations were performed based on the standard methods [6]. Features like colour, pH, Organic Carbon, Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Sulphates, Iron, Zinc, Manganese, Copper were assessed [7].

Determination Germination Index of the Composts: The composts were also subjected for determination of the germination index values, to know there possible application as a soil rejuvenator. This is performed by allowing the wheat beans to germinate in filter papers properly soaked in the aqueous extracts of the compost. The results were compared with the standard germination enhancer (gibberellin) [8].

The percentage of relative seed germination, relative root elongation and germination index are calculated by the following formula.

$$\text{Relative seed germination (\%)} = \frac{\text{Number of seeds germinated in extract}}{\text{Number of seeds germinated in control.}} \text{X100}$$

$$\text{Relative root growth (\%)} = \frac{\text{Mean root length in extract}}{\text{Mean root length in control}} \text{X100}$$

$$\frac{\text{Germination index} = \text{(relative seed germination x relative root growth)}}{100}$$

RESULTS AND DISSCUSSION

The results for chemical analysis of the completed compost are given in the Table. 1, from the observations it is evident that the overall quality of the compost has greatly improved in case of the compost done with beneficial microbial consortia. The carbon and Nitrogen values have simply doubled whereas other desired components have also improved very well. Further for the compost moistened with the distillery spent wash there was significant enhancement of the overall quality of the compost, although there was a meager increase in the values of metal ions also but this increase is not so significant.

The results for germination index values have been given in the Table 2. Which reflect that the germination index values were dramatically increased in case of the composting done with consortia from 45 to 80. In case of the compost obtained with consortium and spent wash the germination index values further increased marginally from 80 to 86.67.

These results are indicative that the compost obtained using the above discussed method could very well be used as a soil rejuvenator and being rapid it will also help in quicker management of the municipal solid waste and also the spent wash to some extent.

Table 1: Chemical analysis of completed compost after aerobic composting.

Parameter	Untreated (control)	Consortia	Consortia + Spent Wash
Colour	Dark Brown	Dark Brown	DarkBrown
pH	7.3	7.5	7.1
Organic carbon	10%	20%	23%
Nitrogen	1.2%	3%	4.2%
Phosphorous	2%	2.8%	3.9%
Potassium	1%	1.5%	2.2%
Calcium	1.9%	2.4%	2.5%
Magnesium	0.7%	0.8%	0.9%
Sulfates	0.5%	0.7%	0.9%
Iron	0.6%	0.6%	0.7%
Zinc	0.006%	0.007%	0.009%
Manganese	0.007%	0.008%	0.008%
Copper	0.006%	0.006%	0.007%

Table 2: Germination index values for the final compost

Compost	Control	With Consortia	With Consortia and spent wash
No. of seed germinated in Extract	9	12	13
No. of seed germinated in control	30	30	30
Mean root length in extract (mm)	3	4	4
Mean root length in control. (mm)	2	2	2
Relative seed germination	30	40	43.33
Relative root growth	150	200	200
Germination Index.	45	80	86.67

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