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Addressing the challenges of sugarcane trash decomposition through Effective Microbes

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Abstract. Burning of sugarcane crop residues in Tamil Nadu, India is a common practice among the farmers due to lack labour availability and less duration for the next crop. Insitu composting of sugarcane trash can be a good alternate to mitigate these problem. Earlier research confirm that sugarcane trash compost can be achieved by using microorganisms like *Aspergillus flavipes, Penicillium, Chrysogenum, Cochliolous speifer, Rhizopus oryzae* and *Trichoderma viride*. In few places of Tamil Nadu farmers are practicing indigenous techniques for the cane trash decomposition. Though the composting is better option for sugarcane trash decomposition but the time taken is more. In some cases it goes even up to 180 days. Effective Microbes are variety of microorganisms grown as consortium which plays a great role in converting wastes into compost in short span of time. In this study we have tested effective microbes prepared through fruit wastes which was found to be very effective in converting sugarcane trash into compost in 60 days.

Keywords: Sugarcane trash, effective microbes, composting

1. Introduction

Sugarcane is one of the important cash crops in India and plays pivotal role in both agricultural and industrial economy of the country. India is one of the largest producers of sugar and is in close competition with Brazil for the top position. In India, sugarcane is cultivated over an area of 4 million hectares and the production is estimated to be about 325 million tonnes with productivity of 70 tonnes per hectares. In Tamil Nadu, India, sugarcane is cultivated in an area of 3.22 lakh hectares with an average productivity of 101.8 tonnes. India need to produce more than 320 million tones of sugarcane to cater the crushing requirement of sugar factories operated in the country. Greater attention is given only in improving the sugar cane yield and not much in managing the cane trash. In India approximately 6.5 million tonnes of sugar cane trash are being produced every year and most of the residues are usually burnt in the field due to lack of proper composing techniques. Besides the loss of organic matter and plant nutrients, burning of crop residues also causes atmospheric pollution due to the emission of toxic gases methane, carbon di oxide that poses threat to human and ecosystem. Insitu composting of cane trash can be a good alternate to mitigate these problem. Earlier study confirmed that *Aspergillus flavipes, Penicillium, Chrysogenum, Cochliolous speifer, Rhizopus oryzae* and *Trichoderma viride* were found effective in sugarcane trash decomposition (Shweta *et al.* 2010). Though the composting is better option for sugarcane decomposition but the time taken is little high. In recent years integrated system of composting, with bioinoculants and subsequent vermicomposting, to overcome the problem of lignocellulosic waste degradation of different crop residues and waste industrial by-products is receiving worldwide attention of scientists (Shweta *et al.* 2010). Effective Microbes (EM) are variety of microorganisms grown as consortium.

EM consist of common and food-grade aerobic and anaerobic micro-organisms: photosynthetic bacteria, *lactobacillus*, *streptomyces*, actinomycetes, yeast, etc (Higa *et al.* 1994). The strains of the micro-organisms are commonly available from microbe banks or from the environment.

2. Methods

A known quantity of raw materials viz fruit wastes (500g), vegetable wastes (500g) and Mixed Liquid Suspended Solids (MLSS) (500g) were collected and stored in cold storage room. About 50 g each of above said raw materials were taken in 6 different containers (two samples from each raw material). The first set of three raw materials was added with 20g of carbon source in order to increase the native microbial population. The second set of three raw materials was stored without the addition of carbon source for comparison. These two sets of raw materials were kept under room temperature for enhancing the microbial growth for about three days. After third day, the samples were taken from these two sets and used for isolation of microorganisms using serial dilution-plate count method. The microorganisms isolated from the raw materials with and without the addition carbon were sub cultured then placed in pure culture slants.

The remaining raw materials (400g) were shade dried for about 48 hours, ground well and made it into powder form. From these processed raw materials, samples were taken and analyzed for their nutritional characteristics using standard analytical methods. The moisture content of the raw materials viz fruit wastes (68%), Vegetable wastes (79), MLSS (69%) were brought down to 30% by the addition aged cow dung compost (Moisture content 10%). Addition of aged compost not only reduces the moisture content of the raw materials but also increases the microbial load. These raw materials were used for preparing EM through conventional method.

2.1. Preparation of different effective microbe's formulation

Laboratory Method: Five predominant bacterial colonies from fruit wastes, five from vegetable wastes and five from MLSS were selected for the preparation of EM formulations. These colonies were inoculated in 3 separate containers (EM1, EM2, EM3) containing nutrient broth. Then these microbes were allowed to mass multiply. Ten days later these EM formulations EM1 (microbial colonies isolated from fruit wastes), EM2 (microbial colonies isolated from vegetable wastes), EM3 (microbial colonies isolated from MLSS) were used for assessing their potential in sugarcane trash decomposition.

Conventional Method: Jaggary syrup solution was prepared using 250 g jaggary in 250 ml of water. The fruit wastes (pumpkin and papaya) were cut into small pieces and made to pulp. Then the fruit pulp and jaggary solution were mixed in an earthen pot containing 2 litres of water. After proper mixing a known quantity of rhizosphere soil (250g) were taken from fertile sugarcane crop field and added in to earthen pot. Then the pot was covered with white cloth, lid and placed in shade for 10 days. By this time the microbes would multiply in enormous number and thus the EM – F (EM prepared using Fruit wastes) was prepared. The same procedure was followed for preparing EM - V (EM - prepared using vegetable wastes) and EM - S (EM - prepared using MLSS).

2.2. Assessing the sugar cane trash degradable potential of EM formulation under in-vitro study

Sugarcane trashes were collected from near by Sugarcane Breeding Institute (SBI), Coimbatore, Tamil Nadu, India and shade dried for 48 hours. Then the trashes were chopped into small pieces. A known quantity of sugarcane trash (500g) each were taken separately in four compost chambers and the moisture level was maintained at 60%. A known quantity of EM formulations EM1, EM2, EM3 were added to first three compost chambers and the fourth chamber (control) was left un inoculated for comparison. All the four compost chambers were kept air tight and the moist air was supplied through the small tubes connected at the bottom of the chamber. The evolved CO_2 from the compost chamber were passed through a tube connected to an air tight container containing alkali (3M NaOH). The liberated CO_2 was calculated once in 3 days by taking the sample

from the alkali storage containers. The alkali was changed once in every three days. The compost samples were taken from the compost chamber once in 15 days and analyzed for compost quality and maturity index using standard analytical methods. Similar experiments were conducted with EM-F, EM-V, EM-S by replacing EM1, EM2, and EM3.

2.3. Assessing the sugar cane trash degradable potential of EM formulation under bench scale composting

A known quantity of sugarcane trash (500 g) was taken in three different plastic trays. One of the trays was added with 100 ml of EM-F and another tray with 100 ml of EM-F and 10 g urea. Third tray was added with neither EM-F nor urea for comparison. Moisture content was maintained at 60%. Periodical samples were drawn once 15 days to test total carbon, Nitrogen and C:N ratio.

To test the conversion efficiency of EM-F at increased quantity, another experiment was conducted by increasing the quantity of sugarcane trash to 1kg. In this experiment 1kg each of sugarcane trash was taken in three different plastic trays. One of the tray was added with 200 ml of EM-F and another tray with 200 ml of EM-F and 20 g urea. Third tray was added with neither EM-F nor urea for comparison. Moisture content was maintained at 60%. Periodical samples were drawn once 15 days to test total carbon, Nitrogen and C:N ratio.

2.4. Maintaining mother stock of Effective Microbial Consortia

The EM-F was found to be superior in converting cane trash into compost within 60 days. Effective microbes formulation (Fruit wastes based) was prepared by following indigenous method and the mother stock EM-F was stored for further study. Jaggary syrup solution was prepared using 500 g jaggary in 500 ml of water. The fruit wastes (pumpkin and papaya) were cut into small pieces and made to pulp. Then the fruit pulp and jaggary solution were mixed in an earthen pot containing 4 litres of water. After proper mixing, a known quantity of rhizosphere soil (500g, free from stones and foreign bodies) were taken from fertile sugarcane crop field and added in to earthen pot. Then the pot was covered with white cloth, lid and placed in shade for 10 days. Once in a day the lid was opened and mixed well with a help of sterilized glass rod. This would offer enough oxygen for the growth of microbes in the EM. By this time the microbes would multiply in enormous number and thus the EM – F (EM using Fruit wastes) was prepared. A known quantity of EM-F (200ml) was taken and mass multiplied in another earthen pot containing 4 litres of water and nutrient source. From this a known quantity of EM-F 100 ml was taken and stored in conical flask under controlled condition.

3. Results

The raw materials namely fruit waste, vegetable wastes, MLSS added with carbon source were found to be rich in microbial load when compared to the raw materials left without carbon source. This shows that addition of small quantity of carbon source activated the microbes present in the raw materials. On comparison, the bacterial and fungal population was high in raw material added with carbon source than the raw materials without carbon source. Among three raw materials, MLSS was found to be rich in bacterial population when compared to fruits and vegetable wastes. The EM prepared through laboratory method (EM1, EM2, EM3) and conventional method (EM-F, EM -V and EM-S) were used to test their effectiveness in converting the sugarcane trash into compost. The over all degradable potential of EM prepared through laboratory method was lower than the EM produced through conventional method. This might be due to the non availability of nutrients to the diversified group of microorganisms in the medium used in laboratory method. Among the three EM tested (EM-F, EM -V and EM-S) the fruit pulp based EM was found to be very effective in converting sugarcane trash in to compost.

The EM-F was once again tested against sugarcane trash decomposition in two different experiments with 500 g and 1kg sugarcane trash. Both the experiment confirms that the EM-F played a vital role in reducing the C/N ratio of sugarcane trash. The sugarcane trash left uninoculated with EM-F recorded a C/N ratio of 30:1 at 60th day of composting. Where as the sugarcane trash inoculated with EM-F recorded a C/N ratio of 14.44:1 at

60th day of composting. Addition of nitrogen source reduced the C/N ratio (13.25) still lower than 14.44:1. This might be due to the increased concentration of nitrogen (Mahimairaja et al. 1994). This again confirms that effective microbe played a major role in reducing the C/N ratio. Thus our findings confirm, the EM produced through conventional method is effective in degrading sugarcane trash when compared to EM prepared through laboratory method. Among the three EM formulation prepared by conventional method, the fruit wastes based EM (EM-F) was superior in converting sugarcane trash to compost. EM-F converted sugarcane trash into compost in 60 days. The EM-F was rich in lactic acid bacteria (*Lactobacillus*), yeast (*Sacharomyces*), actinimycetes (*Streptomyces*), fungi (*Aspergillus*).

4. Reference

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Table 1. Evolved CO_2 concentration during the decomposition of sugarcane cane trash under in-vitro study I

Treatments	Cumulative CO_2 release (g kg^{-1})				
	Initial	15th day	30th day	45th day	60th day
T_1 - Sugarcane trash + E 1	0	28	62	132	159
T_2 - Sugarcane trash + E 2	0	25	75	127	161
T_3 - Sugarcane trash + E 3	0	39	65	145	155
T_4 - Sugarcane trash	0	14	31	42	75

Values are the means of four observations. Results are expressed on air dry weight basis.

Table 2. Evolved CO_2 concentration during the decomposition of sugarcane cane trash under in-vitro study II

Treatments	Cumulative CO_2 release (g kg^{-1})				
	Initial	15th day	30th day	45th day	60th day
T_1 - Sugarcane trash + EM-F	0	82	163	218	256
T_2 - Sugarcane trash + EM-V	0	56	104	156	211
T_3 - Sugarcane trash + EM-S	0	61	125	161	125
T_4- Sugarcane trash	0	16	28	44	65

Values are the means of four observations. Results are expressed on air dry weight basis.

Table 3. Changes in total carbon during the decomposition of sugarcane trash under bench scale composting

Treatments	Total Carbon (g kg^{-1})

	Initial	15th day	30th day	45th day	60th day
T_1 - Sugarcane trash + EM-F	315	280	220	205	200
T_2 - Sugarcane trash + EM-F + Urea	330	290	230	210	205
T_3 - Sugarcane trash	360	330	300	290	270

Values are the means of four observations. Results are expressed on air dry weight basis.

Table 4. Changes in total nitrogen during the decomposition of sugarcane trash under bench scale composting

Treatments	Total Nitrogen (g kg^{-1})				
	Initial	15th day	30th day	45th day	60th day
T_1 - Sugarcane trash + EM-F	8.1	9.5	13.8	13.9	14.2
T_2 - Sugarcane trash + EM-F + Urea	7.9	9.8	14.5	14.7	15.1
T_3 - Sugarcane trash	7.5	8.1	8.4	8.9	9.0

Values are the means of four observations. Results are expressed on air dry weight basis.

Table 5. Changes in C/N ratio during the decomposition of sugarcane trash under bench scale composting

Treatments	C/N ratio				
	Initial	15th day	30th day	45th day	60th day
T_1 - Sugarcane trash + EM-F	40.74:1	30.53:1	16.67:1	15.11:1	14.44:1
T_2 - Sugarcane trash + EM-F + Urea	39.87:1	28.57:1	15.17:1	13.95:1	13.25:1
T_3 - Sugarcane trash	48.00:1	40.74:1	35.71:1	32.58:1	30.00:1

Values are the means of four observations. Results are expressed on air dry weight basis.