

Efficiency of newly isolated proteolytic, lipolytic and amylolytic bacterial isolates on degradation of different agro-wastes

LIVLEEN SHUKLA¹, KUMAR PRANAW² and SURENDER SINGH³

Indian Agricultural Research Institute, New Delhi 110 012

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ABSTRACT

Three bacterial strains with proteolytic, lipolytic and amylolytic activities were tested for their efficiency in enhancing the biodegradation of different organic wastes. The organic material was inoculated initially with fungal inoculant (5.0 g/kg). Bacterial consortia (1% v/w) were added after thermophilic phase and composting was carried out for 100 days. The samples drawn regularly and analyzed for organic carbon, total nitrogen, humus content and available P. The results showed that bacterial consortia inoculation enhanced the decomposition of different residues and reduced the composting time by 20–30 days.

Key words: Amylolytic bacteria, Biodegradation, Leaf trash, Lipolytic bacteria, Paddy straw, Proteolytic bacteria, Wheat straw

Recycling of crop residues through composting is a highly desirable option for the farmers. Organic wastes mainly constitute cellulose, hemi-cellulose, starch, lipids, proteins, fats and carbohydrates. To decompose heterogeneous mass of organic wastes choice of microorganisms is important. Composting is the biochemical degradation of the organic fraction of solid waste material resulting in end product rich in humus like substances. Natural decomposition of agro-waste is slow because of high lignocellulose (90% approx) content of crop residues. Therefore, a consortium of efficient microorganisms is needed for rapid composting of agro-wastes. The objective of the present study was to evaluate the consortium of selected fungi, proteolytic, lipolytic and amylolytic bacteria and actinomycetes for bioconversion of organic wastes.

MATERIALS AND METHODS

The study was conducted in cemented pits at the Division of Microbiology of the Indian Agricultural Research Institute (IARI), New Delhi during 2008–09. Each pit was filled with paddy straw, wheat straw (collected from IARI fields) and leaf trash (collected from the roadsides of IARI). The initial C/N ratio of all the residues was adjusted to 50 : 1 with poultry droppings. All the pits were first inoculated with fungal consortia of *Aspergillus awamori*, *A. nidulans*,

Trichoderma viride, *Phaenerochaete chrysosporium* @ 500 g/tonne. Once the thermophilic phase is over (after 1–2 weeks) a mixed amylolytic, lipolytic and proteolytic bacterial inoculum was added (1% v/w). The study was conducted for 3 months and the samples were drawn after 0, 30, 60 and 90 days of composting. The composting was terminated after 4 months. The samples were analyzed in terms of organic carbon, nitrogen, C/N ratio, available P and humus content (Gand et al. 2009).

Microbial analysis in terms of colony forming units/g was performed with a dilution plating method on different media, ie total bacterial count on nutrient agar, lipolytic bacteria count on medium with tributyrin, proteolytic bacteria count on agar medium with milk and for amylolytic bacteria enumeration starch agar was used. Organic carbon was determined by combustion method (Hesse 1971), total phosphorus by method of Jackson (1967), humus content sodium pyrophosphate method of Konnova (1966) and Total N content was analyzed by Kjeldahl's method (Jackson 1967).

RESULTS AND DISCUSSION

During composting of mixed waste of paddy straw, wheat straw, and leaf trash, the maximum loss in organic matter was observed after addition of the fungal and bacterial inoculants. The biodegradation was around 39.2% during the first month of composting. The reduction was considerably lower in subsequent months resulting in 57.72% degradation after 90 days. In the control treatment only 28.8% reduction

¹Senior Scientist (e mail: livleen_micro@yahoo.co.in), ²Senior Research Fellow (e mail: kumarpranaw036@yahoo.co.in), ³Scientist (e-mail: sshau@yahoo.co.in), Division of Microbiology

was observed. Similarly Gostkowska *et al.* (1996) reported over 2-fold decrease in organic matter content after bacterial inoculation, in the early stage of biodegradation of tobacco waste, as compared with the treatments containing natural microbial load. This is in confirmation with the results obtained by Gaur *et al.* (1990).

Microbiological quantitative studies indicate distinctive tendency in the increase of total bacteria count during biodegradation (Fig 1). The maximum changes were recorded for treatment with an addition of 1% bacterial consortium. After 90 days of composting the bacteria count increased about 50 times and reached the level of over 10^8 cfu/g. Corresponding results were observed by Jorgensen *et al.* (2000) throughout composting process of oil residue with the addition of biopreparations. Addition of bacterial consortium had a beneficial influence on proteolytic, lipolytic and amylolytic bacteria count during mixed waste biodegradation. As shown in Fig 1 the composition of mixed waste stimulated amylolytic and proteolytic bacteria compared with the lipolytic bacteria.

Lower content of lipolytic and amylolytic bacteria could have resulted from the fact that the most of lipase and amylase enzymes are subjected to typical catabolite repression and their production could be inhibited by the presence of easily

assimilated carbon sources. Similar trends towards changes in bacteria enumeration were revealed in compost without addition of any compost inoculants. The physiochemical properties of different composts obtained after the degradation process are given in Table 1, which showed that wheat straw and paddy straw decomposed in 100 days with 6.39% and 8.91% humus content respectively. Leaf trash decomposed in 90 days with 14.7% humus content.

Table 2 clearly shows the changes in organic carbon (%), Total N, C/N ratio, available P and humus content respectively. The organic carbon content of compost prepared from wheat straw without any inoculation reduced to 52.9% after 90 days of composting while in case of inoculation with fungi and bacteria consortium almost same per cent reduction in organic carbon (54.3%) was obtained after 60 days. Similar trend was found in total N, available phosphorus and humus content in all the substrates. This might be due to synergistic effect of fungal and bacterial inoculants on the degradation process (Beary *et al.* 2002, El Din and Abo Sedera 2001). There was progressive loss of carbon with passage of time, the difference in rate of decomposition due to treatments over control during first month was significant but later it was at par.

Total N: An appreciable increase was observed in total N

Table 1 Physiochemical properties of various composts prepared from various organic wastes after 120 days

Substrate	Available P (ppm)	C/N	Humus (%)	pH	EC (mS/cm)
Wheat straw (uninoculated control)	122	31.4	5.02	8.69	1.8
Wheat straw + fungal consortia	158	23.3	5.67	9.23	2.0
Wheat straw + fungal consortia +isolated inoculants	200.2	17.1	6.39	8.72	2.1
Paddy straw (uninoculated control)	264	35.8	6.37	8.42	2.0
Paddy straw + fungal consortia	293	19.7	7.43	8.91	2.5
Paddy straw + fungal consortia + isolated inoculants	352	14.2	8.91	9.23	2.9
Leaf trash (uninoculated control)	280	30.4	12.2	7.95	1.4
Leaf trash+ fungal consortia	340	17.8	12.9	8.79	1.8
Leaf trash+ fungal consortia +isolated inoculants	309	12.1	14.7	8.86	2.2

Table 2 Changes in Carbon (%), N (%), Available P (ppm), and Humus (%) during degradation of different organic wastes

Treatments	C (%)			N (%)			Available P (ppm)			Humus%		
	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days	30 days	60 days	90 days
Wheat straw (uninoculated control)	41.9	30.6	25.5	0.76	1.07	1.14	48.7	46.6	90.8	3.0	10.2	12.02
Wheat straw + Fungal consortia	39.8	27.8	22.8	1.02	1.31	1.28	50.1	44.1	124.2	5.8	13.7	14.67
Wheat straw + Fungal consortia + Isolated inoculants	37.7	26.2	22.0	1.34	1.52	1.61	69.8	54.6	149.2	6.1	13.9	16.9
Paddy straw (uninoculated control)	40.6	29.8	24.8	0.92	1.14	1.28	49.2	47.9	108.9	3.9	11.9	15.6
Paddy straw + Fungal consortia	38.1	28.1	23.1	1.08	1.32	1.29	49.4	46.9	147.9	6.3	13.2	16.6
Paddy straw + Fungal consortia + Isolated inoculants	36.1	27.9	21.8	1.54	1.42	1.48	76.8	69.3	112.6	6.2	14.2	17.6
Leaf trash (uninoculated control)	37.4	29.8	26.7	0.82	1.00	1.34	82.0	78.5	126.9	4.3	14.1	16.2
Leaf trash+ fungal consortia	36.0	27.6	22.5	0.93	1.41	1.37	90.1	70.5	135.9	5.8	16.4	17.9
Leaf trash+ fungal consortia + Isolated inoculants	35.7	27.2	20.9	1.09	1.56	1.63	76.4	67.2	192.2	6.9	17.2	18.5

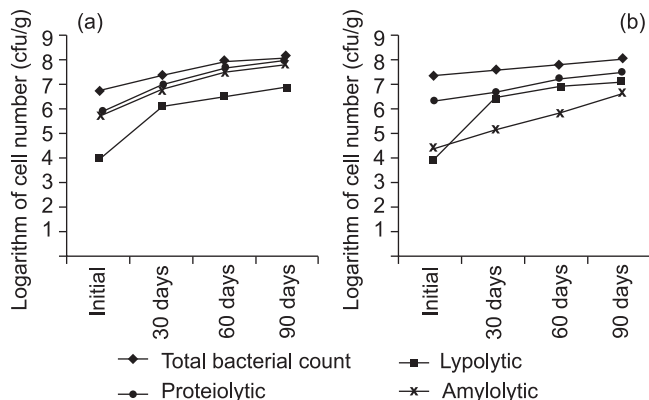


Fig 1 Changes in bacteria population during the biodegradation process of organic waste (a) With bacterial inoculants and (b) Without bacterial inoculants

content in all treatments (Table 2). The maximum increase was observed with leaf trash inoculated with fungal and bacterial consortia. In the finished compost, a gain of 27.3% N was recorded over uninoculated control. Similar results were obtained by Pandey *et al.* (2009) during composting of paddy straw.

C/N ratio: The C/N ratio dropped down markedly and ranged from 14.2 to 35.8 in different treatments during composting. In the mature compost C/N ratio dropped further, ranging between 14 and 18 compared with the control. Leaf trash inoculated with fungal and bacterial consortia showed maximum loss in carbon and increase in N content.

Available P: Availability of P increased during first 30 days in all treatments as compared to uninoculated control. The decrease in available P during 60 days may be due to microbial immobilization of soluble P. In the finished compost maximum available P was noted with leaf trash and fungal inoculant.

Humus: A progressive increase in humus content was observed during decomposition process. All the treatments showed 4 to 5 times increase in humus and were superior

over the control. The maximum humus (18.5%) was found in treatment where leaf trashes were added along with fungal and bacterial consortia.

The bacterial strains used in the present study can be used along with conventional fungal inoculants for the production of enriched compost from different organic wastes which will help in reducing the composting time. The process can be adopted for bioconversion of agro-wastes to produce manures for sustainable agriculture.

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