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Management of Biogas spent slurry for hastening the composting of agro residues

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Abstract: The demand for energy and the fertilizers are ever increasing. Organic farming has many advantages looking to the environment pollution, unproductive soil, less yields etc. By installation of a biogas plant serves both the purposes of meeting the fuel as well as obtaining manures. The organic manures need to be added in bulk to meet the nutrient demands of the crop as it is not in concentrated form like chemical fertilizers. Hence, biogas spent slurry is the best alternate for hastening the compost preparation of abundantly available crop residues as well as obtaining enriched compost as conventional method takes long time. Moreover, slurry is composed of major nutrients besides enzymes and a rich microflora. Based on the preliminary results, the present study was conducted at farmer's field to know whether slurry could be used for degradation of agro residues. One ton of crop residues that included banana waste, sunflower and maize waste, leaf litter of horticultural crops were inoculated individually with 60 L of spent slurry along with consortia of degrading fungi and P-solubilising bacteria. After a retention period of 60 days, nutrients were analysed. The cultures along with slurry indicated 1.5 - 1.96 % N with reduction in C:N ratio between 1.6 - 1.82. The micronutrients also increased. Thus, it was concluded that efficient use of spent slurry can be made besides utilising the crop residues and the product for organic cultivation.

Keywords: Biogas spent slurry, enrichment, groundnut yield

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1. Introduction: The demand for conserving natural resources and energy, has led to the concept of recycling of organic wastes. The conventional method takes a long time to produce food compost. Decomposition of organic matter is a natural process responsible for the breakdown of complex compounds. The activity of microorganisms in succession continues until all the organic substances are mineralized. Increase in the rate of decomposition and nitrogen conservation was observed on addition of phosphate during composting **[1, 2].** Highly enriched compost was prepared from plant wastes by the addition of 25 % musssorie rock phosphate **[3]**. An experiment on recycling of banana wases was conducted with microbial inoculants viz. *Pleurotus* and *Penicillum*. The composted banana has showed lowering in carbon levels and increase in nitrogen, phosphorous and potassium content after 2 months of degradation **[4]**. The BSS can be successfully recycled for production of vermicompost in large capacity biogas plants **[5]**. The demand for energy / fuel and the fertilizers are ever increasing. Organic farming has many advantages looking to the environment pollution, unproductive soil, less yields etc. At the same time, they need to be added in bulk to meet the nutrient demands of the crop as it is not in concentrated form like chemical fertilizers. Biogas plant serves both the purposes of meeting the fuel as well as obtaining manures. Moreover, slurry is composed of major nutrients besides enzymes and a rich microflora.

Hence, biogas spent slurry is the best alternate for hastening the compost preparation of abundantly available crop residues as well as obtaining enriched compost. In the present study, an attempt has been made to know the role of degradation cultures along with BSS and whether only BSS can be enriched with phosphorous.

2. Maintenance of cultures and Procedure for composting: *Phanaerochaete chrysosporium, Pleurotus sp, Trichoderma viridae* and *A sydowii* were maintained on PDA agar. The banana waste, mixed crop residues, leaf litter were the types of organic wastes selected at individual farmers sites. The particle size of the crop residues were reduced to 4-5 inches except inleaf litter which was used as such. Te residues were dumped @ of 200 Kg in five layers within an area of 5 m x 3 m on the ground surface. Inbetween the layers, 100 g of each degrading microbial culture (*Pleurotus sp., Phanerochaete chrysosporium, aspergillus awamorii and Trichoderma viride*) and 100 g of P- solubilsers (PSBD1 and PSBD-2) were spread along with rock phosphate @ 2 %. A total of 60 L of BSS was sprinkled all over the layers and covered with either mud or paddy straw to retain moisture. At every 8-10 days one turning was advised for aeration. After retention period of 60 days, the samples were analysed for various mutrients such as carbon, nitrogen, phosphorous, potassium by standard methods and minor elements – zinc, copper, managanese & rron by using AAS.

3. Enrichment of BSS with phosphorous: The six PSB cultures were obtained from UAS, Dharwad, HAU, Hissar, TNAU Coimbatore and Courtallam, TN. The cultures were screened *invitro* for phosphate solubilising activity by the zone of solubilisation activity on agar media. The promising cultures were tested quantitatively for P- solubilisation on modified Sperberger's medium at intervals of 5, 10 & 15 days. Further the two promising strains PSB D-1 & PSB TN-2 (100 g lignite based culture) were inoculated to 100 L of BSS along with rock phosphate of 500 g. THE treatments wer e allowed for 45 days for the activity and 40 % moisture was maintained. THE nutrient composition of the enriched slurry was also carriedout.

4. Effect of enriched BSS on yield and yield components of Groundnut:
Crop variety: Groundnut TAG-24
RDF: 25:75:25 NPK Kg/ha Gypsum: 500 Kg/ha
Seed rate: 150 Kg /ha
Duration : 100-120 days

The yield and yield parameters were observed.
Analysis: The N, P, K & carbon content were analysed as per the standard methods.

5. Results and Discussion: The results of the nutrient analysis indicate a drastic reduction in the C:N ratio was noticed in all samples. In banana waste (Table No.1), available P and K found to be increased. The nitrogen content varied from 1.5 to 1.96 % depending upon the substrates. However, pH was alkaline after degradation indicating microbial activity.

Table 1: Nutrient status of the microbially degraded Banana waste, at farmer's sites at 60 days.

Sl. No	Parameters	Banana waste (At Hampinhole)			Banana waste (At Bagalkot)		
		Initial	Inoculated	Uninoculated	Initial	Inoculated	Uninoculated
1	Nitrogen %	0.70	1.50	0.83	0.92	1.92	1.27
2	Carbon %	46.40	27.30	37.37	48.0	29.70	38.30
3	C:N ratio %	66.28	18.20	45.71	52.17	15.46	30.15
4	Available P %	0.56	1.88	0.51	0.20	1.77	0.78
5	Available K %	1.86	1.82	0.53	0.28	2.17	1.18
6	Moisture %	80	23	25	70	40	48
7	pH	7.0	8.0	7.0	6.5	8.5	7.4

Note : The quantity of substrates was 1 tonne Inoculated: BSS+Microbial cultures+Rock phosphate.

The C:N ration was between 16.1 to 18.2 which was within the ideal standards. Similar results are observed with crop residues (Table 2) and leaf litter (Table 3).

Table 2: Nutrient status of the microbially degraded, crop residues at farmer's sites at 60 days.

Sl. No	Parameters	Crop residues (At Aralikatti)			Crop residues (At Uppinabetageri)		
		Initial	Inoculated	Uninoculated	Initial	Inoculated	Uninoculated
1	Nitrogen %	0.84	1.63	0.88	0.82	1.58	1.34
2	Carbon %	27.49	27.49	30.93	40.00	25.13	36.34
3	C:N ratio %	16.86	16.86	30.93	48.78	16.00	27.11
4	Available P %	1.91	1.91	0.81	0.09	1.83	0.78
5	Available K %	1.19	1.19	0.69	0.56	0.71	1.20
6	Moisture %	38	38	42	70	30	50
7	pH	6.0	6.0	7.2	6.4	7.4	7.1

Table 3: Nutrient status of the microbially degraded, leaf litter at farmer's sites at 45 days.

Sl. No	Parameters	Leaf litter (At Dharwad)		
		Initial	Inoculated	Uninoculated
1	Nitrogen %	0.98	1.96	1.25
2	Carbon %	46.4	31.70	36.73
3	C:N ratio %	47.34	16.17	29.38
4	Available P %	0.30	1.81	0.87
5	Available K %	0.37	2.34	0.82
6	Moisture %	75	35	46
7	pH	6.0	8.3	7.1

The inoculated samples showed higher nutrient status compared to uninoculated samples. The micronutrient status of all the samples indicated that there was increase in the nutrients (Table 4).

Table 4: Micronutrient content of compost samples.

Sl. No	Compost samples	Zn (ppm)	Cu (ppm)	Mn (ppm)	Fe (ppm)
1	Biogas spent slurry	56.2	42	393	2282
2	Agro waste(Aralikatti)	695	37	1150	2389
3	Banana stem (Hampinahole)	992	40	317	2752
4	Leaf litter (Dharwad)	926	44	238	3806
5	Crop residue (Uppinabetageri)	688	41	1124	2262
6	Banana stem (Bagalkot)	884	45	349	2876

In the invitro studies, all the cultures showed P- solubilisation. As the period of incubation increased, the abialble P also increased, but, varied with the cultures. Maximum solubilsiatioan was by PSB D-1 followed by TN-2. (Table 5).

Table 5: Enrichment of PSB cultures for P- solubilisation *invitro.*

Phosphate solubilising bacterial strains	Available Phosphorous (%) at different periods of incubation		
	5 DAI	10DAI	15DAI
PSB-D1	3.58	5.41	10.92
PSB-D2	3.56	6.00	10.53
PSB-H	3.36	4.96	8.36
PSB-TNAU-1	3.33	4.68	8.86
PSB-TNAU-2	3.66	5.00	9.10
PSB- Courtallam	2.08	4.68	5.46

Table 6: Nutrient status of BSS enriched with rock phosphate and P-solubilisers (45 days).

Cultures	Carbon %	Nitrogen %	Phosphorous %	Potassium %	C:N ratio	Population of P-solubilisers (cfu x 10^4 /g BSS)
PSB-D1	26.9	1.77	1.51	1.74	15.19	27.6
PSB-D2	34.4	1.56	1.16	1.68	22.05	20.0
PSB-H	32.8	1.47	0.93	1.51	22.35	21.3
PSB-TNAU-1	31.6	1.49	0.96	1.65	21.25	20.0
PSB-TNAU-2	30.9	1.66	1.51	1.70	18.61	31.3
PSB-Courtallam	35.1	1.48	0.74	1.19	23.44	5.6
BSS + Rock Phosphate	36.7	1.45	0.69	1.12	25.33	Nil

Maximum available P & N content and reduction in C: N was also maximum by these cultures. (Table 6). Plant growth parameters viz., plant height, number of branches, number of modules per plant and root length showed increasing trend in soil supplemented with different doses of phosphate enriched BSS and recommended doses of fertilsiers. These parameters were significant in P-enriched BSS treatment. Among the BSS enriched cultures, PSB-D1 and TN-2 had similar effect on growth parameters of groundnut.

Table 7: Effect of phosphate enriched BSS with P-solubiliser PSB D1 on the growth parameters of groundnut at flowering stage.

Treatments	Plant hight (cm)	No of branches /plant	No of nodules /plant	Root length (cm)
100 %BSS+ RDF	27.1	3.6	16.6	14.2
100%RDP	27.9	3.3	18.6	13.1
75%RDP	30.0	4.0	15.9	14.1
50%RDP	29.1	3.3	15.9	14.1
100% Enr BSS	25.8	3.3	17.0	13.7
50% Enr BSS +50% RDP	26.3	2.6	18.3	14.0
25% Enr BSS +75% RDP	28.6	3.3	18.3	14.3
75% Enr BSS +25% RDP	31.8	3.6	19.3	14.6

Application of enriched BSS with RDF at different doses had positive effect over application of RDF alone at different doses (Table 7, 8 & 9). The number of pods and pod weight per plant were significantly highest in the combined application of enriched BSS +RDF. Similar results were obtained in shoot and root wt. The yields were significant in P enriched with PSBD1 as compared to that of fertilisers. The results of the trial at farmer's site also showed increase in yields (Table 10). The response by the farmers was highly satisfactory.

Table 8: Effect of phosphate enriched BSS with P-solubilisers (PSB-D1) on the yield parameters of groundnut at harvest.

Treatments	Shoot dry weight (g/ plant)	Root dry weight (g/plant)	No of pods /plant	Pod weight (g/plant)
100 %BSS+ RDF	7.9	1.30	21.3	39.4
100%RDP	8.0	1.06	18.6	35.6
75%RDP	5.1	1.03	10.6	14.1
50%RDP	4.8	0.93	10.3	18.7
100% Enr BSS	7.0	1.10	18.0	26.9
50% Enr BSS +50% RDP	7.4	1.14	21.6	35.7
25% Enr BSS +75% RDP	8.0	1.31	26.0	43.3
75% Enr BSS +25% RDP	8.2	1.30	24.0	38.6

Table 9: Effect of P enriched BSS on growth and yield parameters of groundnut.

Treatments	Shoot wt. at harvest (g/plant)	Root wt. at harvest (g/plant)	Pod yield (g/plant)	Yield (q/ha)
100 % BSS	21.68	0.88	34.22	17.87
100 % RDF	24.01	1.29	45.01	24.45
75 % RDF	26.21	1.11	40.18	22.09
50 % RDF	23.04	1.03	38.69	21.27
100 % Enrc. D1 PSB	23.13	1.05	38.6	20.22
50 % RDF+ 50 % Enr.D1	25.52	1.26	43.78	21.89
75 % RDF +25 % D1	24.14	1.35	46.43	24.33
25% RDF +75 % D1	22.27	1.1	40.6	21.72

100% Enr.TN2	24.58		1.01		37.17		19.94	
50% RDF+ 50% Enr.TN2	23.59		1.23		43.44		22.11	
75% RDF +25% TN2	25.44		1.23		46.15		23.42	
25% RDF+75% TN2	24.68		1.07		39.07		21.42	
	SE±	CD at 5 %	SE±	CD at 5 %	SE±	CD at 5 %	SE±	CD at 5 %
Year	0.18	0.62	0.009	0.031	0.48	NS	0.2	0.69
Treatments	0.49	1.38	0.035	0.099	0.73	2.06	0.6	1.69
Interactions	0.86	2.43	0.06	NS	1.27	NS	1.04	NS

Table 10: The performance of P-enriched BSS on yield of groundnut at farmer's sites.

Sl. No	Name of the center	Name of the farmer/ village	Variety of groundnut	Yield (q/ha)	
				T1 P Enr. BSS	T2 RDF
1.	K.V.K. Tukkanatti	Shri Shrikant Busi, Ghodageri	DH-86	22.25	19.75
2.	E.E.U, Dharwad	Jambaiah Chikmath,Yemmetti, Kalghatgi	JL-24	22.50	19.00
	E.E.U, Dharwad	Gulappa Akki, Yemmetti, Kalghatgi	JL-24	23.50	19.50
4.	Scientists	Pakkirappa G. Bhadrashetti, Lakamapur, Dwd.	JL-24	22.00	19.50
	Scientists	Babu J Mujavar, Uppinabetageri	JL-24	17.00	15.00
5.	K.V.K. Hanumanmatti	-	-	10.00	8.00

Note: Area was one acre. RDF : Recommended dose of fertilisers

6. Conclusions:

1. PSB-DI and PSB TNAU-2 cultures are efficient in P solubilization and hence can be used for enrichment of slurry.
2. The microbial consortium is highly effective in biodegradation of the crop residues when inoculated along with BSS. A retention period of 60 days is enough for complete formation of the compost.
3. The compost developed can reduce the chemical fertilizer requirement by 25-50 % without affecting the yields. It is the best way to manage the crop residues for clean environment.

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