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Research Paper

Effect of Quantity and Frequency of Distillery Spent Wash Application on Changes of Physico-Chemical Profile during Bioconversion of Pressmud using Lingo-Cellulolytic Microorganisms

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Abstract

A laboratory experiment was conducted to study the effect of quantity and frequency of distillery spent wash application on changes of physic-chemical properties *viz*., pH, EC, organic carbon, C / N ratio and nutrient content of pressmud compost during 30, 60, 90 and 120 days of composting. This experiment was carried out at UAS, Bangalore with three ratios (quantity) of 1:2, 1:3 and 1:4 and four intervals (frequency) of spent wash application *viz.,* daily once, once in two days, once in three days and once in four days. Totally, there were twelve treatments with three replications. Composting was carried out in plastic containers by using 10 kg of pressmud as substrate. The consortium of ligno-cellulolytic microorganisms was inoculated layer by layer at the rate of 2.5 kg per ton of substrate. The initial quantity of spent wash added was equivalent to maintain the moisture level approximately at 60 per cent level. The remaining quantity of spent wash was distributed up to 60 days of composting by adding equal quantity to each container once in two days. Composting was carried out for 120 days by regularly turning the materials once in 15 days and maintaining the moisture approximately at 60 per cent level by adding water under controlled conditions. Samples were drawn at random during 30, 60, 90 and 120 days of composting from all the treatments and analyzed for various physic-chemical properties. From the results it was observed that a substrate to spent wash ratio of 1:3 at an application frequency of two days was the best treatment compared to all the other treatments.

India is one of the largest producers and consumers of sugar in the world. Among the Indian agro-based industries, sugar industries are the most important, which contribute substantially to the economic development of the country by providing employment opportunities both directly and indirectly. 579 sugar industries in the country produce 19.0 million tons of sugar by crushing 145 million tons of sugarcane. They produce 7.0 million tons of pressmud, 7.5 million tons of molasses and 45 million tons of baggasse as by-products annually (Selvamurugan *et al*., 2013). These by-products were once considered as wastes and sugar mills had problems of disposal. Distilleries are the major agro-industries that generate large quantity of alcohol from molasses, a by-product of sugar industries. As on date, there are 319 distilleries in India with a production capacity of 3.25 billion litres of alcohol per annum. From these distilleries, 40.72 million-kilo litres of spent wash is being generated annually as wastewater and the disposal of spent wash is posing a problem (Mohana *et al*., 2009). The ever-increasing generation of distillery spent wash on the one hand and stringent legislative regulations of its disposal on the other has stimulated the need for developing new technologies to process this effluent efficiently and economically. Spent wash, once being considered as a pollutant, is no more a pollutant and it is fastly emerging as an eco-friendly organic liquid nutrient supplement to improve the fertility and productivity of the nutrient starved soils of India. Distillery spentwash with major, secondary and micronutrients is also rich in organic matter, an essential ingredient to improve the physical, chemical and biological properties of soil (Naidu, 2004). The post methanated spentwash contains 0.70-1.15 per cent potassium (K_2O), 0.08-0.12 per cent nitrogen (N) and 0.01-0.03 per cent phosphorus (P_2O_5) and also appreciable amounts of secondary and micronutrients. So, it can be used as a liquid fertilizer and return the nutrients to the soil by adopting suitable soil and crop management practices. The treated spentwash could be composted along with the pressmud into useful organic manure. It can be done with the help of microbial consortia. This may lead to a great potential and scope for eco-friendly

management for sustainable agricultural production (Ramaswamy, 1999). Further, this would also help distilleries to dispose off the wastes and minimize the use of chemical fertilizers for crop production. Keeping this in view, the study was conducted to standardize the quantity and frequency of application of spent wash for bio-composting to produce good quality matured pressmud compost.

Material and Methods

In order to identify the ideal quantity and frequency of spent wash application for composting using pressmud as substrate, the experiment was carried out at UAS, Bangalore with three ratios (quantity) of 1:2, 1:3 and 1:4 and four intervals (frequency) of spentwash application *viz.,* daily once, once in two days, once in three days and once in four days. Totally, there were twelve treatments with three replications. Composting was carried out in plastic containers by using 10 kg of pressmud as substrate. The microbial consortium of ligno-cellulolytic organisms (*Phanerochaete chrysosporium* (Department of Environmental Science, TNAU, Coimbatore), *Pleurotus sajor-caju, Trichoderma harzianum* (Department of Agricultural Microbiology, UAS, Bengaluru) and *Trichurus spiralis* (MTCC, IMTECH, Chandigarh)) was inoculated layer by layer at the rate of 2.5 kg per ton of substrate. The initial quantity of spentwash added was equivalent to maintain the moisture level approximately at 60 per cent level. The remaining quantity of spentwash was distributed up to 60 days of composting by adding equal quantity to each container once in two days. Composting was carried out for 120 days by regularly turning the materials once in 15 days and maintaining the moisture approximately at 60 per cent level by adding water under controlled conditions. Samples were drawn at random during 30, 60, 90 and 120 days of composting from all the treatments and analyzed for various parameters. Physico-chemical properties *viz.,* pH, electrical conductivity, organic carbon, total N, P and K of the compost were determined by following the standard procedures given by Jackson (1973). C / N ratio was also worked out for the compost during different intervals. The *data* obtained were subjected to Duncan *Multiple Range Test* (DMRT) for the test of significance *using MSTAT*-C statistical software.

Results and Discussion

Changes of pH and electrical conductivity during bio-composting of pressmud : The results on changes in pH and EC of compost materials at different intervals during bio-composting of pressmud as influenced by the quantity and frequency of spent wash application are presented in Table I. In general, there was an increase in pH values with increase in the quantity of spent wash application and the pH decreased with decrease in the frequency of spent wash application. On the other hand, there was also increase in the pH values with increase in the period of decomposition in all the treatments. At 120th day of composting, the highest pH was observed in the treatment of 1:4 pressmud (PM) to spent wash (SW) ratio with a frequency of daily once (pH 7.84), which was on par with the treatment of 1:3 (PM:SW) with the same frequency (pH 7.81). On the other hand, the lowest pH was observed in the treatment of 1:2 (PM: SW) with a frequency of once in four days (pH 7.33), which was significantly lower from all other treatments. The data on EC revealed that there was an increase in EC values with an increase in the quantity of spent wash application and decreased with decrease in frequency of spent wash application. On the other hand, there was a marginal decrease in EC values with increase in the period of decomposition in all the treatments. At the final stage of composting, highest EC was observed in the treatment of 1:3 (PM:SW) with an application frequency of daily once (2.81 dSm^{-1}) which was on par with the treatment 1:4 (PM:SW) with same frequency of application (2.78 dSm^{-1}), while, lowest EC was noticed in the treatment of 1:2 (PM:SW) with an application frequency of once in four days (1.77 dSm^{-1}) which was on par with the treatment of same quantity, but, with a frequency of once in three days. This could be attributed to the quantity of distillery spent wash applied to pressmud rich in salts. Whereas in, the ratio 1:3 (PM: SW) at a frequency of daily once and in the ratio 1:4 (PM: SW) with all frequencies resulted in anaerobic situation with more than 70 per cent moisture content. The decrease

TABLE I

Changes in pH and EC during bio-composting of pressmud as influenced by quantity and frequency of distilery spent wash application

Ratio of application	Treatment		pH				EC (dSm^{-1})			
			Period of decomposition (days)				Period of decomposition (days)			
			30	60	90	120	30	60	90	120
1:2 (PM:SW)	T_1	Daily once	7.30 ^{bc}	7.39 ^{c}	7.52 ^{e}	7.70 ^{b}	2.87 ^{c}	2.72 ^{c}	2.67^{b}	2.45 ^{c}
	T_2	Once in two days	7.21 ^{d}	7.31 ^{de}	7.44 ^{f}	7.54 ^{d}	2.38 ^{fg}	2.26 ^{g}	2.05 ^{f}	1.91 ^{f}
	T_3	Once in three days	7.18 ^{d}	7.22 ^{fg}	7.34 ^{g}	7.44 ^{ef}	2.30 ^{g}	2.12 ^{i}	2.03 ^{f}	1.80 ^{g}
	T_4	Once in four days	7.06^{f}	7.12^{h}	7.23^{h}	7.33^{g}	2.03^{h}	2.04^{j}	1.91^{g}	1.77^{g}
1:3 (PM:SW)	T_5	Daily once	7.34 ^{ab}	7.55 ^{b}	7.77 ^{b}	7.81 ^{a}	2.88 ^{c}	2.96 ^{b}	2.92 ^{a}	2.61 ^{b}
	T_6	Once in two days	7.27 ^{c}	7.42 ^{c}	7.58 ^{d}	7.63 ^{c}	2.68 ^{d}	2.36 ^{ef}	2.27 ^{d}	2.81 ^{a}
	T_7	Once in three days	7.10 ^{ef}	7.25 ^{fg}	7.48 ^{ef}	7.54 ^{d}	2.50 ^{ef}	2.34 ^{f}	2.14 ^{e}	1.89 ^{f}
	T_8	Once in four days	7.07 ^{ef}	7.20 ^{g}	7.34 ^{g}	7.39 ^{f}	2.28 ^{g}	2.17 ^{hi}	2.04 ^{f}	1.89 ^{f}
1:4 (PM:SW)	T_9	Daily once	7.39 ^{a}	7.68 ^{a}	7.82 ^{a}	7.84 ^{a}	3.35 ^{a}	3.23 ^{a}	2.96 ^{a}	2.78 ^{a}
	T_{10}	Once in two days	7.28 ^{c}	7.54 ^{b}	7.65 ^{c}	7.71 ^{b}	3.04 ^{b}	2.48 ^{d}	2.45 ^{c}	2.26 ^{d}
	T_{11}	Once in three days	7.12 ^{e}	7.33 ^{d}	7.48 ^{ef}	7.55 ^{d}	2.60 ^{de}	2.41 ^{a}	2.23 ^{d}	1.98 ^{e}
	T_{12}	Once in four days	7.10 ^{ef}	7.27 ^{ef}	7.44 ^{f}	7.48 ^{e}	2.41 ^{fg}	2.21 ^{gh}	2.13 ^{e}	1.91 ^{f}

Note: Mean values followed by the same superscript in each column do not differ significantly at P=0.05 level by DMRT

in pH values could be due to production of organic acids during the process of decomposition. Similar results have also been reported by Patil *et al*. (2007), where, it has been tried up to 1:5 ratio (PM: SW) for composting using pressmud as substrate.

Changes of organic carbon content and C/N ratio during bio-composting of pressmud : The data on OC (%) content at different intervals during bio-composting of pressmud as influenced by quantity and frequency of spent wash application are presented in Table 2. The data showed significant differences among various treatments at all the intervals of decomposition. In general, there was a reduction in OC content of the treatments with increase in the period of decomposition. Moreover, there was an increase in OC content with the increase in quantity of spent wash application, while, it decreased with decrease in the frequency of application. At 120th day of bio-composting, the highest OC content was observed in the treatment 1:4 (PM:SW) with an application frequency of daily once (27.4 %) which was significantly different from all other treatments, while, the lowest OC content was noticed in the treatment 1:3 (PM:SW) with application frequency of once in four days (24.2 %) which was on par with the treatment that received 1:4 (PM:SW) with spent wash application frequency of once in four days (24.5 %).

C:N ratios at different intervals during bio-composting of pressmud as influenced by quantity and frequency of spent wash application have been worked out and are presented in Table II. The results showed significant changes in the C:N ratios among various treatments at all the intervals of decomposition. There was an reduction in the C:N ratio of all the treatments with increase in the period of composting. In general, decrease in C:N ratio was observed with increase in the quantity of spent wash application and decreased with decrease in the frequency of spent wash application. At final stage of composting, the highest C:N ratio was noticed in the treatment that received

TABLE II

Changes in OC (%) content and C/N ration during bio-composting of pressmud as influenced by quantity and frequency of distillery spent wash application

Ratio of application	Treatment		OC (%) Period of decomposition (days)				CN ratio Period of decomposition (days)			
			30	60	90	120	30	60	90	120
1:2 (PM:SW)	T_1	Daily once	28.7 ^{e}	27.3 ^{e}	26.5 ^{c}	26.2 ^{c}	26.7 ^{ab}	21.7 ^{e}	19.9 ^{d}	19.2 ^{e}
	T_2	Once in two days	28.1 ^{e}	26.5 ^{g}	26.2 ^{d}	26.0 ^{cd}	27.4 ^{ab}	22.4 ^{d}	21.2 ^{c}	20.9 ^{d}
	T_3	Once in three days	27.6 ^{f}	26.3 ^{h}	25.7 ^{f}	25.4 ^{e}	27.4 ^{ab}	23.2 ^{c}	22.4 ^{a}	22.1 ^{a}
	T_4	Once in four days	26.3 ^{h}	26.2 ^{h}	25.5 ^{g}	25.0 ^{f}	27.1 ^{ab}	24.1 ^{b}	22.3 ^{a}	22.1 ^{a}
1:3 (PM:SW)	T_5	Daily once	30.0 ^{d}	29.0 ^{b}	27.1 ^{b}	27.0 ^{b}	26.3 ^{b}	20.5 ^{f}	18.8 ^{f}	17.9 ^{g}
	T_6	Once in two days	28.3 ^{e}	27.0 ^{f}	26.5 ^{c}	26.1 ^{cd}	26.8 ^{ab}	21.6 ^{e}	17.6 ^{h}	16.5 ^{i}
	T_7	Once in three days	28.3 ^{e}	26.8 ^{f}	25.9 ^{e}	25.8 ^{d}	27.4 ^{ab}	23.4 ^{c}	21.2 ^{c}	21.2 ^{c}
	T_8	Once in four days	26.7 ^{g}	26.5 ^{g}	25.4 ^{g}	24.2 ^{g}	26.3 ^{b}	25.5 ^{a}	21.8 ^{b}	21.6 ^{c}
1:4 (PM:SW)	T_9	Daily once	32.4 ^{a}	30.7 ^{a}	28.5 ^{a}	27.4 ^{a}	24.0 ^{c}	19.6 ^{g}	19.2 ^{ef}	17.1 ^{h}
	T_{10}	Once in two days	31.7 ^{b}	28.1 ^{c}	26.5 ^{c}	26.1 ^{cd}	28.1 ^{a}	19.1 ^{h}	18.1 ^{g}	18.0 ^{b}
	T_{11}	Once in three days	30.7 ^{c}	27.8 ^{d}	26.0 ^{e}	26.1 ^{cd}	27.7 ^{ab}	23.1 ^{c}	19.4 ^{e}	19.3 ^{e}
	T_{12}	Once in four days	29.7 ^{d}	26.9 ^{f}	25.7 ^{f}	24.5 ^{g}	27.2 ^{ab}	25.3 ^{a}	22.7 ^{a}	21.6 ^{c}

Note: Mean values followed by the same superscript in each column do not differ significantly at P=0.05 level by DMRT

spent wash at 1:2 (PM:SW) ratio with application frequency of once in four days (22.1) and was on par with the treatment that received same quantity of spent wash but with application frequency of once in three days (22.1) while the lowest C:N value was observed in the treatment that received spent wash at 1:3 (PM:SW) ratio with application frequency of once in two days (16.5) and was significantly lower compared to all other treatments.These changes might be attributed to an increased total N content with increase in the quantity of spent wash application. The decomposition of pressmud is accelerated by its powder form, which absorbs more of distillery spent wash that is rich in nitrogen. Similar results are also obtained by several workers, they found that when nitrogen was added to any organic substrate to lower down the C: N ratio, it resulted in the loss of carbon in the organic wastes (Patil *et al.*, 2007; Sunil, 2002; Lekshmi, 2002).

Changes of total N, P and K during bio-composting of pressmud : The results on changes in total N, P and K content during bio-composting of pressmud as influenced by quantity and frequency of spent wash application are presented in Table III. There was a significant increase in all major plant nutrients over the period of decomposition. In general, the total NPK contents increased with quantity of spent wash applied and decreased with decrease in the frequency of spent wash application. The highest total N was observed in treatment 1:4 (PM: SW) with a frequency of daily once (1.62 %) which was on par with treatment of 1:3 (PM: SW) ratio with a frequency of once in two days (1.60 %), whereas, total P and K contents were found to be higher with treatment 1:4 (PM: SW) ratio with an application frequency of daily once (1.45 and 1.95 %, respectively). In general, the treatments with spent wash application at higher

TABLE III

Changes in total N, P and K content during bio-composting of pressmud as influenced by quantity and frequency of distillery spent wash application

Ratio of application	Treatment		N (%)				P (%)				K (%)			
			Period of decomposition (days)				Period of decomposition (days)				Period of decomposition (days)			
			30	60	90	120	30	60	90	120	30	60	90	120
1:2														
(PM:SW)	T_1	Daily once	1.04 ^{def}	1.28 ^{d}	1.35 ^{c}	1.38 ^{d}	0.93 ^{de}	1.16 ^{de}	1.22 ^{cd}	1.26 ^{def}	1.35 ^{de}	1.51 ^{c}	1.62 ^{f}	1.63 ^{g}
	T_2	Once in two days	1.02 ^{fg}	1.20 ^{fg}	1.25 ^{d}	1.25 ^{e}	0.82 ^{gh}	1.00 ^{g}	1.19 ^{de}	1.21 ^{gh}	1.28 ^{fg}	1.43 ^{d}	1.55 ^{g}	1.59 ^{gh}
	T_3	Once in three days	1.00 ^{g}	1.14 ^{hi}	1.16 ^{e}	1.13 ^{f}	0.78 ^{h}	0.92 ^{h}	1.13 ^{f}	1.17 ^{h}	1.20 ^{h}	1.34 ^{e}	1.49 ^{a}	1.56 ^{h}
	T_4	Once in four days	0.98 ^{g}	1.10 ^{ij}	1.15 ^{e}	1.10 ^{f}	0.63 ^{i}	0.79 ^{i}	1.04 ^{g}	1.10 ^{i}	1.12 ^{i}	1.27 ^{f}	1.42^{i}	1.54 ^{h}
1:3														
(PM:SW)	T_5	Daily once	1.14 ^{bc}	1.42 ^{c}	1.45 ^{b}	1.52 ^{b}	1.08 ^{b}	1.22 ^{bc}	1.30 ^{b}	1.32 ^{bc}	1.42 ^{bc}	1.70 ^{a}	1.77 ^{cd}	1.79 ^{de}
	T_6	Once in two days	1.10 ^{def}	1.26 ^{de}	1.52 ^{a}	1.60 ^{a}	0.99 ^{c}	1.17 ^{cde}	1.27 ^{cd}	1.28 ^{cde}	1.35 ^{de}	1.63 ^{b}	1.73^{de}	1.78 ^{ef}
	T_7	Once in three days	1.03 ^{efg}	1.16 ^{gh}	1.25 ^{d}	1.14 ^{f}	0.88 ^{ef}	1.14 ^{e}	1.20 ^{de}	1.25 ^{efg}	1.28 ^{fg}	1.59 ^{b}	1.68 ^{e}	1.74 ^{ef}
	T_8	Once in four days	1.00 ^{g}	1.04 ^{k}	1.18 ^{e}	1.12 ^{f}	0.80 ^{gh}	1.08 ^{f}	1.15 ^{ef}	1.22 ^{fgh}	1.23 ^{gh}	1.53 ^{c}	1.61 ^{f}	1.71 ^{f}
1:4														
(PM:SW)	T_9	Daily once	1.35 ^{a}	1.58 ^{a}	1.50 ^{ab}	1.62 ^{a}	1.14 ^{a}	1.31 ^{a}	1.39 ^{a}	1.45 ^{a}	1.49 ^{a}	1.74 ^{a}	1.87 ^{a}	1.95 ^{a}
	T_{10}	Once in two days	1.17 ^{b}	1.48 ^{b}	1.48 ^{ab}	1.45 ^{c}	1.07 ^{b}	1.23 ^{b}	1.31 ^{b}	1.35 ^{b}	1.45 ^{ab}	1.69 ^{a}	1.84 ^{ab}	1.90 ^{ab}
	T_{11}	Once in three days	1.08 ^{de}	1.22 ^{ef}	1.35 ^{c}	1.16 ^{f}	0.96 ^{cd}	1.20 ^{bcd}	1.27 ^{bc}	1.31 ^{bcd}	1.38 ^{cd}	1.63 ^{b}	1.81 ^{bc}	1.85 ^{bc}
	T_{12}	Once in four days	1.09 ^{cd}	1.06 ^{jk}	1.17 ^{e}	1.15 ^{f}	0.85 ^{fg}	1.14 ^{e}	1.23 ^{cd}	1.27 ^{cde}	1.30 ^{ef}	1.61 ^{b}	1.77 ^{cd}	1.81 ^{cd}

Note: Mean values followed by the same superscript in each column do not differ significantly at P=0.05 level by DMRT

frequencies had quite higher values and these results are in confirmation with the results obtained by Patil *et al.* (2007). This could be attributed to the quantity of distillery spent wash applied and frequency in application of spent wash. The changes in total major nutrients during composting at different intervals of pressmud are similar to the results obtained in the previous experiment.

The experiment conducted for optimization of the ideal quantity and frequency of application of distillery spent wash indicated that 1:3 (PM: SW) ratio with a frequency of once in two days of application of spent wash was ideal for bio-composting. By mixing pressmud and spent wash at 1:3 ratio and applying spent wash at a frequency of once in two days with turning every alternate day, a quality bio-compost could be obtained.

References

Jackson, M. L., 1973, *Soil Chemical Analysis*. Prentice Hall of India (Pvt.) Ltd., New Delhi.

Lekshmi, R., 2002, Bio-composts from agricultural residues using distillery yeast sludge and spent wash and their impact on soil and crop productivity. *M.Sc. (Agri.) Thesis*, TNAU, Coimbatore, India.

Mohana, S., Acharya, B. K. and Madamwar, D., 2009, Distillery spent wash: Treatment technologies and potential applications. *J. Haz. Mat.*, **163:** 12-25.

Naidu, M. K., 2004, An overview of effective utilization of distillery spentwash. *Proc. of Seminar on "Eco-friendly technology utilization of sugar factory and distillery wastes*" heldat IAT, 2nd July, Bangalore, pp. 3-14.

Patil, S. G., Angadi, S. S., Hongal, M. M., Nataraja, T. H., Mudenoor, M. G. and Jayanthi, T., 2007, Crop responses to nutrient equivalent based one time application of spent wash. In: The National Conference on "Ecofriendly utilization of recyclable organic resources from sugar and distillery industries for sustainable agriculture, 6-7th March, held at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli-9, Tamil Nadu Agricultural University, Tamil Nadu.

Ramaswamy, P. P., 1999, Recycling of agricultural and agro-industry wastes for sustainable agricultural production. *J. Indian Soc. Soil Sci.*, **47:** 661-665.

Selvamurugan, M., Doraisamy, P. and Maheswari, M., 2013, Biomethanated distillery spentwash and pressmud biocompost as sources of plant nutrients for groundnut (*Arachis hypogaea* L.). *J. Appld and Natrl. Sci.*, **5** (2): 328-334.

Sunil, M. S., 2002, Influence of co-composting of press mud with crop residues and agro-industrial wastes on microbial diversity and its effect on plant growth. *M.Sc. (Agri.) Thesis*, Univ.Agril.Sci., Bangalore, India.

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