ENHANCING THE COMPOSTING OF DOMESTIC ORGANIC WASTE USING ADDITIVES

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Abstract

Composting is a managed process which utilizes microorganisms naturally present in organic matter and soil to decompose organic material. These microorganisms require basic nutrients, oxygen, and water in order for decomposition to occur at an accelerated pace. Composting are sustainable strategies to transform organic wastes into organic amendments, valuable as potting media or soil conditioner. However, the negative aspects of these processes are emissions of greenhouse gases and odorous molecules and final product potentially containing toxic compounds. These negative aspects can be limited through the addition of organic, inorganic or biological additives to the composted mixture. Compost is organic material that can be added to soil to help plants grow. Food scraps and yard waste together currently make up more than 30 percent of what we throw away, and could be composted instead. This Project study aims to present the main characteristics of composting processes with and without additives, show the influence of additives on speed of reactions in compost and report the effects of additives on the properties of the final products (heavy metal and nutrient contents), in view of their use as a soil conditioner or potting media. In agronomic and horticultural operations, compost can be used as a soil amendment, seed starter, mulch, container mix ingredient, or natural fertilizer, depending on its characteristics. In this project the additives such as zeolite and polyethylene glycol are employed to improve the speed and characteristics of compost.

Introduction

Composting Process

Composting is a biological decomposition of organic waste either in an aerobic or anaerobic environment with the former being more common. The organic matters in the waste are consumed by aerobic thermophilic and mesophilic microorganisms as substrates and converted into mineralized products such as CO2, H2O, NH4 + 200 or stabilized organic matters. The resultant compost is a 201 stable, humus-rich, complex mixture that can improve physical properties of the soil. Composting is an aerobic method (meaning it requires air) of decomposing organic solid wastes. It can therefore be used to recycle organic material. The process involves decomposing organic material into a humus-like material, known as compost, which is a good fertilizer for plants. The key to effective composting is to create an ideal environment for the microorganisms to thrive warm temperatures, nutrients, moisture and plenty of oxygen.

Methodology

Materials Used

Compost Bins

One can compost materials indoors using a special type of bin, which shall be bought at a local hardware store, gardening supplies store, or make as die. It should be remembered to tend the pile and keep track of what is thrown in. A properly managed compost bin will not attract pests or rodents and will not smell bad. For compost bin to effectively recycle organic waste it needed size, heat, moisture, aeration and a mixture of plant ingredients.

Figure 1 Compost Bins

Domestic Organic Wastes

Organic waste is any material that is biodegradable and comes from either a plant or an animal. Biodegradable waste is organic material that can be broken into carbon dioxide, methane or simple organic molecules. It comes in manifold forms – biodegradable plastics, food waste, green waste, paper waste, manure, human waste, sewage, and slaughterhouse waste. Organic waste could be turned into compost to grow crops, reducing dependency on chemical fertilizers

Figure 1 Domestic Organic wastes

Soil

Placing soil (about three spadefuls) in the base of a new compost bin will help the process; it will contain the worm eggs and bacteria necessary for the compost process to begin. Adding larger volumes of soil to compost would offer no great benefit. Add soil to the top of compost any time, but make sure the soil is dry. Wet soil could cause the compost to become too wet, which may create a slimy pile with pest.

Figure 2 Soil

Wood or Saw Dust

Sawdust makes a perfect amendment for compost pile, as it adds filler that is somewhat absorptive and will pick up water from rain and juices from the green material, helping along in the composting process.

Figure 3 Wood or Saw dust

Zeolite

Zeolite can help you get usable compost quicker, with higher nitrogen retention and less odour. Natural zeolite provides value to the composting processes because of its ability to absorb water and adsorb plant- available nitrogen through cation exchange.

Figure 5 Zeolite

Polyethylene Glycol

Rapid composting of organic waste is the need of the hour in order to accelerate the composting process so as to get the compost in lesser time compared to normal composting. Rapid composting can be achieved by the use of various additives and techniques which enhance the biological activities involved in composting process. Polyethylene glycol is a readily available carbon source that can improve the composting speed.

Figure 6 Polyethylene Glycol

Experimental Setup

Setup Model

For a compost bin, start with a layer of dry carbon material on the bottom, then gradually add alternate layers of green stuff and carbon stuff. Every couple of weeks, add a thin sprinkle of animal manure or other activators. Stop layering once your bin is full, and start another bin. When layering, try to add two parts brown material to one part green. Turn or aerate the compost with a fork every week or two. Another option is to poke garden stakes or plastic pipes through the heap to allow air in. Covering the compost at the top will keep in heat and moisture, which are essential for the process.

Figure 7 Setup Model

Setup without Additives

A setup is made as ordinary composting without adding the selected additives to the compost. This setup is important for its comparison with the ones added with additives. The speed of composting and quality of composting will be studied from the normal composting.

Figure 7 Setup without Additives

Setup with Zeolite

A setup is made with the selected additive, Zeolite. The zeolite is added in powdery form. The zeolite is trusted to improve the speed of composting and its quality as well. Zeolite is an alkaline mineral that is very porous and has a negative charge. Since most toxins, such as heavy metals, radiation, and pesticides are positively charged, Zeolite is pulled towards toxins like a magnet and sucks them up into its structure. Dry powder Zeolite clinoptilolite does not expire if it is stored closed in the jar. Zeolites are extremely useful as catalysts for several important reactions involving organic molecules. The most important are cracking, isomerization and hydrocarbon synthesis. Zeolites can promote a diverse range of catalytic reactions including acid-base and metal induced reactions.

Figure 8 Setup with Zeolite

Setup with Polyethylene Glycol

A setup is made with the selected additive, Polyethylene glycol. The polyethylene glycol is added in pellets form. The polyethylene glycol is trusted to improve the speed of composting and its quality as well. PEG enriches soil, helping retain moisture and suppress plant diseases and pests. Reduces the need for chemical fertilizers.

Figure 9 Setup with Polyethylene Glycol

Setup with Zeolite and Polyethylene Glycol

A setup is made with the selected additives, Zeolite and Polyethylene glycol. The polyethylene glycol is added in pellets form and zeolite in powder form. Both the additives are added to study the combined advantages of the additives in composting.

Figure 10 Setup with Zeolite and Polyethylene Glycol

Results and Discussion

Compost Characteristics

Table 1 Compost Characteristics

S.No	Parameter	Unit	Permissible Limit
1	pH	-	6.8 to 7.6
2	Electrical conductivity	dS/m	<10
3	Total organic carbon	%	Around 54 %

5	Total nitrogen	%	0.5 – 2.0 %
6	Total phosphorus	%	0.5 – 1.0 %
7	Total potassium	%	Around 2.0 %
8	C/N ratio		10.02

PH

The pH of solid waste is of much importance while disposing solid waste anaerobically. The pH value of the digester content is an important indicator of the performance and the stability of an anaerobic digester. In a well-balanced anaerobic digestion process, almost all products of a metabolic stage are continuously converted into the net breaking down product without any significant accumulation of intermediary products such as different fatty acids which would cause a pH drop any aspects of the complete microbial metabolism are greatly influenced by pH variations in the digester.

Table 2 pH Test Data

SI. No	Samples	pH Value				
		Day 0	Day 14	Day 28	Day 42	Day 56
1	S1	7.10	7.20	7.25	7.38	7.42
2	S2	7.90	8.30	8.20	7.72	6.80
3	S3	6.30	8.50	8.62	8.66	8.69
4	S4	7.20	8.00	8.02	7.89	7.63

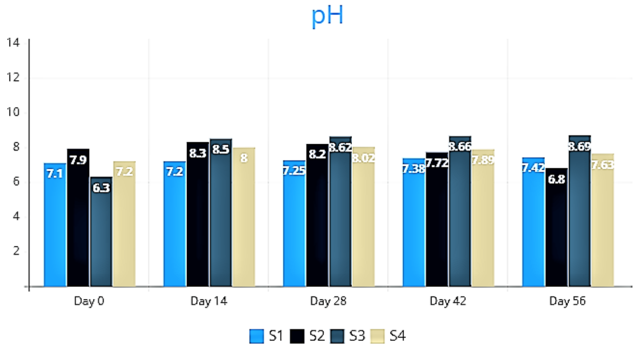

Figure 11 PH Test Graph

Most finished composts are about neutral pH within a range from 6 – 8. However, the initial pH of home compost, being made with the usual mix of vegetable trimmings, food waste and other household compostable material, is likely to be more acidic perhaps between 5.0 and 7.0.

Electrical Conductivity

Compost Electrical Conductivity (EC) of the compost samples were determined using Electrical conductivity Meter according to TMECC method 04-10-A. For the improvement of agricultural soils, the acceptable level of EC required in compost should be lower than 4 dS/m.

Table 3 Electrical Conductivity Test Data

SI. No	Samples	Electrical Conductivity (in dS/m)				
		Day 0	Day 14	Day 28	Day 42	Day 56
1	S1	14.80	13.30	7.40	7.90	8.70
2	S2	6.00	5.00	4.30	3.50	3.00
3	S3	15.30	14.40	17.30	10.10	13.80
4	S4	10.65	9.70	10.80	6.80	8.40

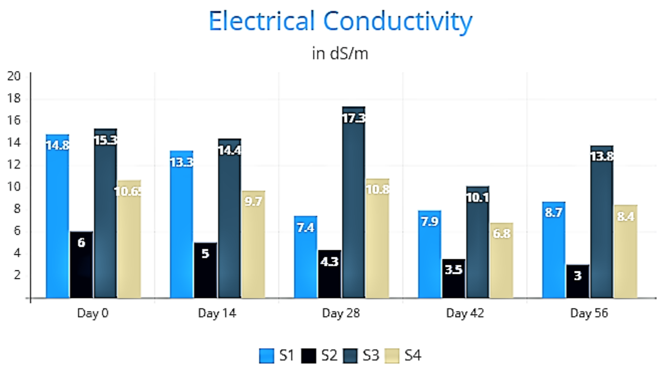

Figure 12 Electrical Conductivity Test Graph

Total Organic Carbon

Total carbon was determined by combustion in a W6sthoff (Carmhograph 12-H Omega) carbon analyser. Total organic carbon (TOC) was deduced by subtracting the inorganic carbon (calcimeter test) from total carbon. The TOC value is then calculated using the simple TOC = TC – TIC formula.

Table 4 Total Organic Carbon Test Data

SI. No	Samples	Total Organic Carbon (in %)				
		Day 0	Day 14	Day 28	Day 42	Day 56
1	S1	45.20	37.80	33.30	32.00	25.10
2	S2	48.50	45.50	44.50	40.00	36.60
3	S3	74.00	71.00	70.00	65.50	62.10
4	S4	61.25	58.25	57.20	52.70	49.35

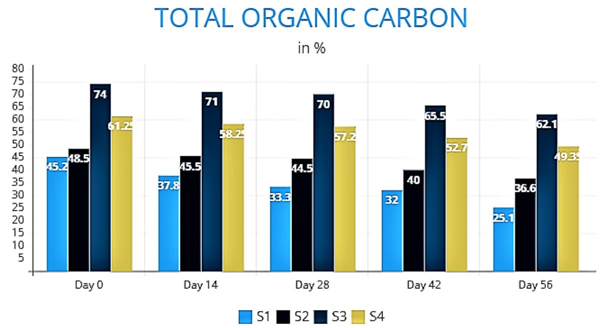

Figure 13 Total Organic Carbon test Graph

Total Nitrogen

Organic N is determined by subtracting the inorganic N forms, NH4-N and NO3-N, from total N. However, because NO3-N levels are generally very low, total nitrogen minus NH3-N provides a good estimate of organic N in most compost.

Table 5 Total Nitrogen Test Data

SI. No	Samples	Total Nitrogen (in %)				
		Day 0	Day 14	Day 28	Day 42	Day 56
1	S1	0.60	0.95	1.30	1.56	1.50
2	S2	1.77	1.80	1.69	1.08	1.77
3	S3	1.16	0.93	1.49	0.50	2.55
4	S4	1.49	1.71	1.31	1.36	1.89

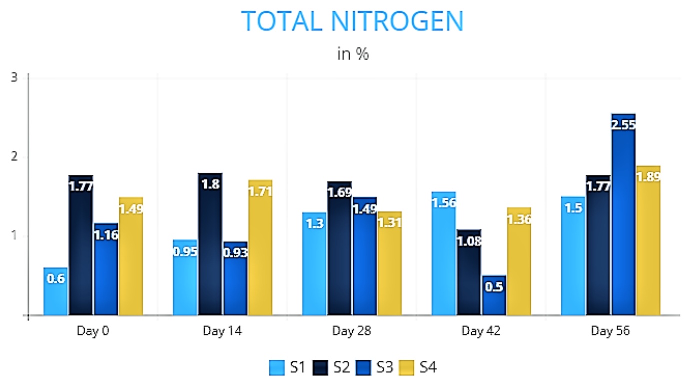

Figure 14 Total Nitrogen Test Graph

Total Phosphorus (TP)

Phosphorus (P) and potassium (K) are plant macronutrients. Values reported are for total amounts given in the oxide forms (P2O5 and K2O). These results provide an indication of the nutrient value of the compost sample. However, plant availability of total phosphorus and potassium in compost has not yet been established.

Table 6 Total Phosphorus Test Data

SI. No	Samples	Total Phosphorus (in %)				
		Day 0	Day 14	Day 28	Day 42	Day 56
1	S1	0.53	0.46	0.26	0.25	0.20
2	S2	0.18	0.40	0.22	0.27	0.36
3	S3	0.16	0.38	0.29	0.29	0.43
4	S4	0.36	0.16	0.38	0.29	0.29

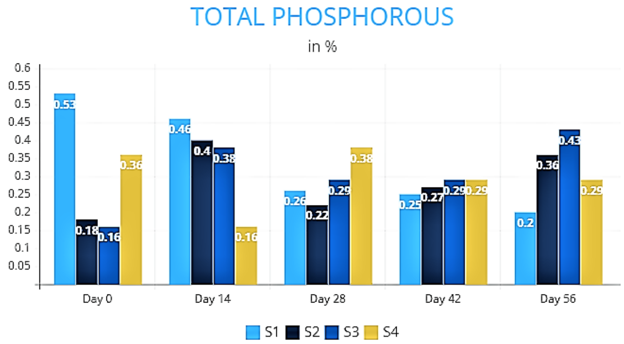

Figure 15 Total Phosphorus Test Graph

Total Potassium (TK)

Compost made primarily from food byproducts is an excellent source of potassium. In particular, banana peels are very high in potassium.

Table 7 Total Potassium test data

SI. No	Samples	Total Potassium (in %)				
		Day 0	Day 14	Day 28	Day 42	Day 56
1	S1	0.80	0.88	0.94	1.02	1.10
2	S2	0.93	0.97	1.09	1.15	1.20
3	S3	0.83	0.91	0.99	1.08	1.16
4	S4	1.13	1.18	1.22	1.27	1.32

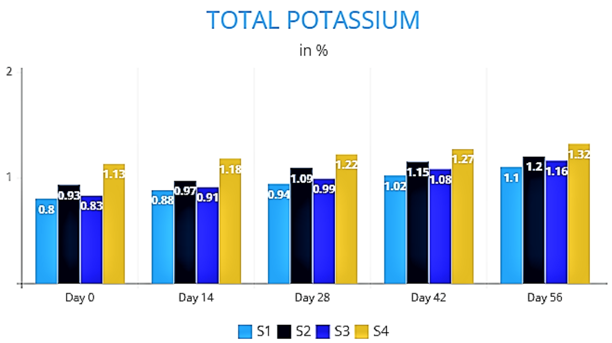

Figure 16 Total Potassium Test Graph

Conclusion

Not all composts are created equal. What goes in as feed stocks partly determines what comes out. Compost quality depends on the composting process used, the state of biological activity, and, most importantly, the intended use of the compost. The four samples after testing for results has shown significant improvement in the characteristics and each one has performed well in one or another parameter. With reference to the pH tested all the four samples remained to be in optimum level of pH and has an average value of about 7.5. The main items a compost pile needs are the proper carbon to nitrogen ratio, small surface area, aeration, moisture, and temperature. Good aeration promotes active aerobic decomposition. When piles are too wet, too large, not porous enough, or are degrading too quickly, aerobic bacteria can't get enough oxygen and anaerobic bacteria take over.

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