PREPARATION OF COMPOST USING BIO-CULTURE FROM DIFFERENT ORGANIC WASTES AND ASSESMENT OF GROWTH OF VEGETABLE PLANT

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Abstract : ***Proper management of vegetable market waste is a serious issue in most of the metropolitan areas. Composting is one of the oldest and easy methods of organic waste stabilization. It is a naturally occurring biological conversion, which produces suitable end products such as fertilizers and BIO-GAS (methane). If these wastes are decomposed in landfills, it generates greenhouse gases, thereby polluting the surrounding environment. Adopting alternatives such as composting and reusing the waste or burning it to generate energy, reduce both pollution and the amount of land devoted to waste disposal. Composting of vegetable market waste is the best option as it can be used in agriculture. The main objective of the research is to make ready to use compost bags having compost made from different organic waste for growing different types of vegetables. Compost will be made from organic waste which includes vegetable waste and bulking agents like rice husk, coconut coir, dry leaves. Finally, the compost will be packed in a UV treated polybags***

IndexTerms - Composting, Organic Waste, Physical Properties, Chemical Properties, UV treated Poly bags.

I. Introduction

Several environmental problems arise from municipal solid waste (MSW) as they are not being properly managed. The major portion of Indian MSW includes vegetable waste. The vegetable waste in MSW is mainly provided by waste from vegetable markets, restaurants, canteens, juice centres and household kitchens. All cities, towns, districts have vegetable markets producing significant quantity of waste. At present, there is a big problem regarding collection, transportation and disposal of waste. The main methods of disposal includes dumping, heaping, land filling and burning and the main problems are environmental pollution, leachate, foul smells, green house gases, spread of diseases and other health hazards. We are facing environmental and socio- economic problems in dealing with current and future planning of disposal and management of fruit and vegetable market waste. Though, proper legislative rules and Standards regarding waste disposal have been made which are not strictly obeyed and waste stuffs are not properly handled and they often pollute the environment. Hence more sustainable and eco-friendly waste management systems are to be made and adopted.

India produces about 50 million tons of municipal solid waste every year from cities. Due to quick development of cities and migration of people from rural to urban, there is the increase in generation of MSW. Over 90 % of these wastes are used for unscientific land-filling or uncontrolled dumping outskirts of towns and cities, which have serious indications of global warming. Presently available MSW management system in India, which includes storage, collection, transportation, segregation, processing & disposal of waste, is not properly developed.

Markets produces fruits and vegetable wastes in massive quantities and result into a noticeable and odour nuisance in municipal landfills because of their high biodegradability. In India, fruit and vegetable waste generates about 5.6 million tonnes annually and presently, these wastes are disposed of by dumping on the outskirts of cities.

Considering India's present urban population to be 330 million, it has an estimated potential of producing 4.3 million tons of compost each year. However, inappropriate solid waste management technique is the main control in production of good quality compost. Improper classification of the MSW at source leads to mixed wastes being composted together and inferior quality product being generated which finds no takers in the market. Composting of vegetable waste results into several benefits such as increased soil fertility and soil health thereby increased agricultural productivity, improved soil biodiversity, reduced ecological risks and a better environment. It destroys harmful pathogens and reduces the volume of waste.

Composting is the process in which aerobic micro-organisms converts organic matter into hygienic, biostable product by thermophilic. This natural process is affected by some environmental conditions like temperature, moisture content, pH and aeration and substrate characteristics like C/N ratio, particle size, nutrients contents and free air space. During degradation of organic matter, moisture content influences the changes in physical and chemical properties of waste material. MSW has high proportion of moisture (80-90%) and organic matter (70-80%) that give raise the odor during decomposition. When the optimum moisture level 60%, is not easily attainable to the micro-organisms, then microbial activity decreases the composting process and temperature 40-70 ^oC will not be accomplished. Most successful moisture level for biodegradation of different compost mixture differs from 50% to 70 %. The presence of more moisture content of MSW, results in significant leachate formation during composting which leads to reduction in porosity and O_2 availability.

The composting process may be more fruitful when the carbon to nitrogen ratio and the moisture content will be specific according to the material of compost. For maintaining the moisture and carbon to nitrogen ratio the bulking agents play a very vital role in the composting. The bulking agents are very effectual to control the air supply, moisture and other important composting parameters.

Bulking agents are usually used to create inter- particle voids, providing air- space in composting materials and controlling the water content of waste. Wood chips, straws, saw dust, rice husk and peanut shells are some bulking agents, which have been mixed with waste materials to alter moisture content, C/N ratio, and void spaces between particles.

Table 1: Various types of bulking agents and their function

Bulking Agent	Function
Sugarcane trash	Regulates carbon content, pH, moisture
Sawdust	Regulates moisture, pH , aeration, bulk density, temperature
Poultry waste	Regulates carbon content, bulk density
Cow dung	Regulates carbon content, bulk density, pH
Rice Husk	Regulates moisture, temperature
Coconut coir	Regulates pH, temperature

In the present study, the vegetable wastes along with bulking agents like rice husk and coconut coir are composted in a drum. Aerobic process is carried out as the holes are drilled on the surface of the drum. The composted material is then packed in a UV treated bag. The bags are such that it can be opened and vegetables can be grown in that bag. The use of grow bag containing compost is more preferable because grow bag can be used even if there is less space, one could get home grown fresh vegetable, it takes less than 20 minutes to plant any vegetable especially those whose roots don't spread too much, it is very useful because plants may be infected by soil borne disease or the soil is contaminated.

II. MATERIAL AND METHODOLOGY

2.1 Collection of Wastes

Vegetable waste was collected from a waste dispersal yard of vegetable market, Navsari District. Discarded vegetables, fruits, dry leaves were collected. Bulking agents like rice husk, coconut coir which is also a one type of waste will be helpful to remove the intense foul odor produced by waste water solids and food waste, controls air supply, moisture and other important composting parameters. The addition of bulking agents switches the compost pile from anaerobic decomposition to aerobic composition. Aerobic composition does not smell pleasant, but its bearable while anaerobic composition smells completely unforgivable. Rice Husk is obtained from rice mill industry and coconut coir from coconut coir industries in southern India.
Initial parameters of raw material utilised for aerobic composting process:

Table 2: Initial parameters of raw material

SR. NO.	PARAMETERS	VEGETABLE WASTE	RICE HUSK	COCONUT COIR
1.	N (%)	2.45	0.98	1.30
2.	P (%)	0.334	0.043	0.068
3.	K (%)	1.60	0.22	0.42
4.	C (%)	23.40	19.65	18.30
5.	C:N ratio	9.55:1	20.05:1	14.13:1
6.	pH	5.31	6.16	3.64
7.	EC	9.47	1.15	3.63

2.2 Classifying wastes into three different samples:

Vegetable waste, coconut coir, dry leaves, rice husk were classified as per operating parameter of compost (method of composting) and as per use of bulking agent. The method of composting includes static pile type and windrow type. Static pile type includes not turning the waste but providing air through horizontal or vertical pipe placed between the bulk of waste. The windrow type includes turning of waste mechanically or manually depending on the quantity of waste.
The different waste has been classified as follows:-

Table 3: Classification of different wastes

SR. NO.	COMPOST (C)	OPERATING CONDITION	WASTE ADDED
1	C-1	Without mixing	Mixture of vegetable waste, dry leaves and rice husk
2	C-2	With mixing	Mixture of vegetable waste, dry leaves and rice husk
3	C-2	With mixing	Mixture of vegetable waste, dry leaves and coconut coir

In C-1 and C-2, the ratio of [6 (VW):1 (RH)] and in C-3, the ratio of [8 (VW):1 (RH)] was taken for composting along with addition of bio-culture.

2.3 Experimental Setup:

Low cost plastic containers of about 10 litre capacity, readily available in supermarkets, were used in this study. The containers were perforated with 0.6 cm diameter holes as shown in figure to provide natural aeration.

Figure 1: Compost Bin

2.4 Composter Operating Condition:

Different wastes were filled in a plastic container as per their classification. By classifying the different wastes as per compost operating parameter, we would be able to see the effect on physical and chemical parameters of compost and also on leachate production and odour.

A bio-culture / compost microbe usually contains cellulolytic and lignolytic microbes was added in all the three samples weekly. Bio-culture was purchased from Daily Dump site as shown in figure and it is in the form of powder. This powder is a culture of micro-organisms which helps to convert our waste into compost faster.

Figure 2: Bio-culture

C-1 type plastic container was not mixed but bio-culture was added weekly. C-2 and C-3 type plastic container was mixed after every 3 days and bio-culture was added weekly. C-1 type act as a static pile type composting method and C-2, C-3 act as a windrow type composting method.

2.5 Compost Monitoring:

The initial parameters of raw materials were checked in the laboratory. Then, on 1st day, 5th day, 20th day, 25th day, 30th day, the samples were dried in the oven and all the parameters like pH, EC, N, P, K, Organic matter, C:N ratio were analyzed in the laboratory.

2.6 Material of Bag:

The material of bag should be such that it can lock temperature and moisture of compost. Also, it should be UV treated to protect the compost from sunlight. The design of bag should be such that it is white from outerside and black from innerside to optimize the growth conditions. The white surface of the bag reflects the sunlight which helps to retain the moisture in it and the black surface inside it helps to minimize the chances for pathogen infestation.

2.7 Method for analyzing different parameters of Compost:

The methods followed for determining the different properties of compost are described as follows:

1) pH - pH of compost samples was determined with the help of digital pH meter having combined electrode with thermo probe using 1: 10 compost water suspension ratio (Jackson, 1968).
2) Electrical Conductivity (dSm^{-1}) - The electrical conductivity of compost samples was determined from 1: 10 compost: water ratio with the help of conductivity meter (Jackson, 1968).
3) Organic matter (%) - Organic carbon of compost samples was determined by preparing ash in the muffle furnace at constant temperature of 550^{o}C. Organic carbon was calculated by multiplying the per cent loss on ignition by 0.58 (Piper, 1950).
4) Total Nitrogen (%) - The organic matter compost samples were digested in H_2SO_4 and made colourless by adding 30% H_2O_2 and cooled. The digested material was transferred to 25 ml volumetric flask and final volume was made 25 ml with distilled water with repeated washing of digestion flasks and the total nitrogen content was determined by Kjeldhal plus apparatus (Jackson, 1968).
5) C: N Ratio - C: N ratio of compost samples was determined by dividing organic carbon by total nitrogen.
6) Total Phosphorus (%) - For determination of total phosphorus of vermicompost samples1.0 g organic matter sample was digested with di-acid mixture (HNO3+HClO4) in 9:4 proportions and the yellow colour was developed with combined vanado-molybdate reagent. Phosphorus was determined calorimetrically by using spectrophotometer at 470 nm wavelength (Jackson, 1968)..
7) Total Potassium (%) - Total potassium of vermicompost samples was estimated flame photometry by feeding diluted di-acid digested solution (Piper, 1950).

III. RESULT AND DISCUSSION:

Table 4: Physio- Chemical Parameters of samples

	pH	EC(dS/m)	N(%)	P(%)	K(%)	Org. Matter (%)	C:N
10 th Day							
Sample 1	7.7	9.7	0.69	0.05	0.44	28.66	41.53
Sample 2	7.5	9.8	0.69	0.1	0.54	25.86	37.47
Sample 3	8.0	8.0	0.9	0.1	0.08	13.08	14.50
20 th Day							
Sample 1	7.2	8.8	0.73	0.09	0.63	25.20	34.52
Sample 2	6.8	9.0	0.76	0.12	0.64	25.35	33.35
Sample 3	6.8	7.8	1.1	0.15	0.17	28.20	25.60
30 th Day							
Sample 1	6.4	8.0	0.80	0.18	0.67	23.00	28.75
Sample 2	5.6	8.4	0.99	0.18	0.68	22.95	23.18
Sample 3	8.6	7.7	1.2	0.2	0.34	17.85	14.8
40 th Day							
Sample 1	5.8	7.6	0.83	0.21	0.72	22.78	27.44
Sample 2	5.9	7.0	1.01	0.23	0.75	22.73	22.5
Sample 3	8.7	5.1	1.25	0.28	0.71	16.20	13.00
50 th Day							
Sample 1	5.0	6.9	0.89	0.29	0.78	22.41	25.18
Sample 2	6.5	6.5	1.04	0.34	0.82	22.11	21.26
Sample 3	8.0	4.5	1.3	0.32	0.98	15.20	11.70

Table 5: Changes in Moisture Content of samples

Sr. No.	Day	Sample 1	Sample 2	Sample 3
1	10	45	50	58
2	20	40	48	53
3	30	38	44	45
4	40	34	40	39
5	50	31	38	33

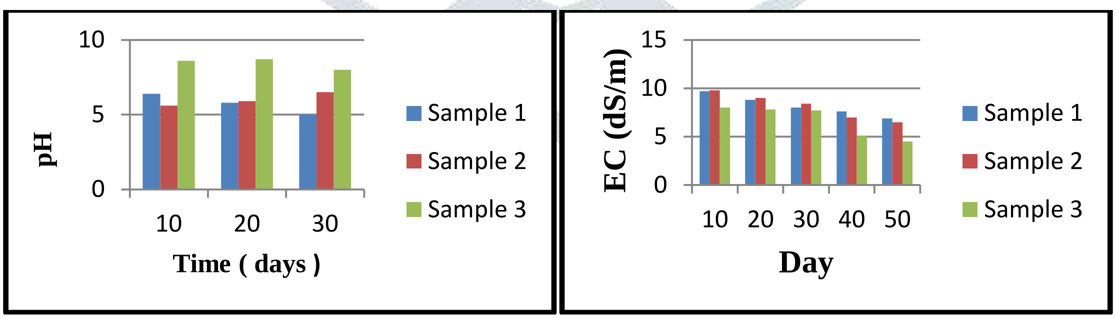

Figure 3: Changes in Ph and EC of samples

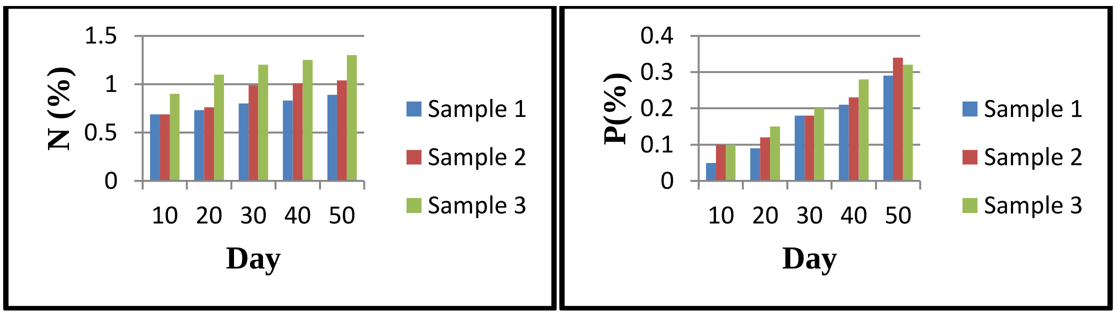

Figure 4: Changes in Total Nitrogen and Total Phosphorus of samples

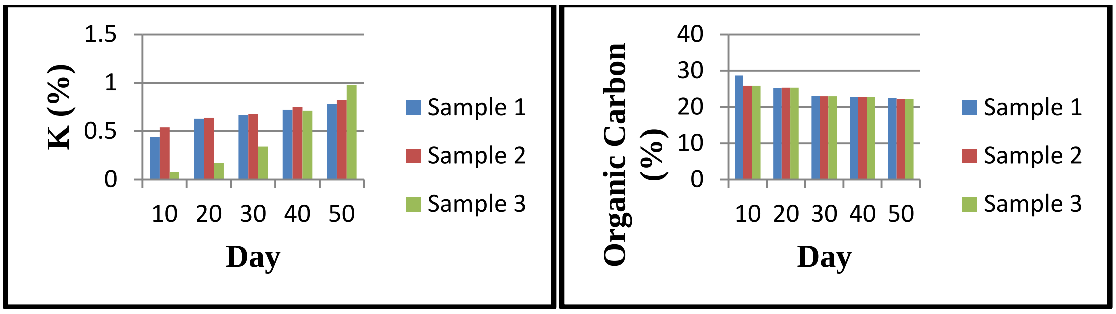

Figure: 5 Changes in Total Potassium and Organic Carbon of samples

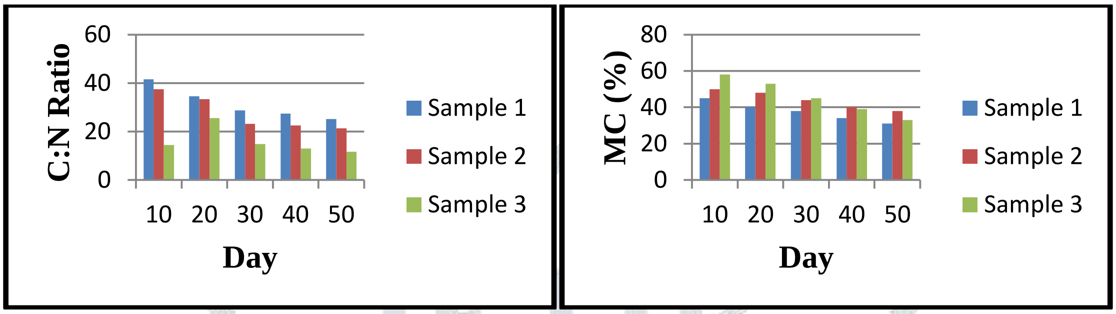

Figure 6: Changes in C: N ratio and Moisture content of samples

Figure 7: Growth of Spinach plant in UV treated polybag

IV. CONCLUSION:

The composting of market vegetable waste along with bulking agents like rice husk, coconut coir is the best and eco- friendly method to reduce the organic waste from the source. This composted material influences the physical and chemical parameters of compost quality and it can be packed in a UV treated polybag for growing different vegetables. This study will be useful for decreasing leachate production and odor during composting process.

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REFERENCES

[1]. Bijaya Adhikari, Suzelle Barington, Jose Martinez and Susan King, "Characterization of food waste and bulking agents for composting", in Waste Management, pp: 795- 804, 2008.

[2]. Fabio Tatano, Giacomo Pagliaro, Paolo Giovanni, Enrico Floriani and Filippo Mangani, "Bio- waste composting: Experimental process monitoring and quality control", in Waste Management, 2015.

[3]. Fan Yang, Guo Xue Li, Qing Yuan Yang and Wen Hai Luo, "Effect of bulking agents on maturity and gaseous emissions during kitchen waste composting", in Chemosphere, pp: 1393- 1399, 2013.

[4]. Gabriela Neata, Razvan Teodorescu, Livin Dinca, and Adrian Basaraba "Physio- chemical and micro-biological composition of composts from Bucharest municipal waste", in Agriculture and agricultural science, pp: 486-491, 2015.

[5]. Jackson, M. L. (1968). Soil chemical analysis.Prentice Hall of India Pvt. Ltd., New Delhi, pp: 134-182.

[6]. Linee Goswami, Anil Nath, Sweety Sutradhar, Satya Bhattacharaya, Ajay Kalamdhad, Kowsalya and Ki- Hyun Kim, "Application of drum compost and vermicompost to improve soil health, growth and yield parameters for tomato and cabbage plants", in Environmental Management, pp: 243- 252, 2017.

[7]. Lucas Guidoni, Roger Marques, Rodrigo Moncks, Fabiana Botlho, Matheus Paz, Luciara Correa and Erico Correa, "Home composting using different ratios of bulking agent to food waste", in Journal of Environmental Management, pp: 141- 150, 2018.

[8]. M. A. Vazquez, R. Sen, M. Soto, "Physio- chemical and biological characteristics of compost from decentralized composting programmes", in Bio resource Technology, pp: 520- 532, 2015.

[9]. Maciej Neugebauer and Piotr Solowiej, "The use of green waste to overcome the difficulty in small scale composting of organic household waste", in Cleaner Production, pp: 865- 875, 2017.

[10]. Muhammad Khalid Iqbal, Tahira Shafiq, and Khurshed Ahmed, "Characterization of bulking agents and its effect on physical properties of compost", in Bio resource Technology, pp: 1913-1919, 2010.

[11]. Piper, C. S. (1950).Soil and Plant Analysis, Hands publisher, Bombay.

[12]. Rodolfo Canet and Fernando Pomares, "Changes in physical, chemical and physic- chemical parameters during the composting of municipal solid wastes in two plants in Valencia", in Bioresource Technology, pp: 259-264, 1995.

[13]. T. Getahun, A. Nigusie, T. Entele, T. Van Gerven, and B. Van der Bruggen, "Effect of turning frequencies on composting biodegradable municipal solid waste quality", in Resources, Conservation and Recycling, pp: 79- 84, 2012.