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EXPERIMENTAL STUDIES ON AEROBIC REACTOR COMPOSTING PROCESS

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Abstract - *The objective of the research is to study the composting process of peanut shell and fruit waste to study the influence of adding the green agricultural residues to compost mixture, study some chemical properties of raw materials and compost during the composting operation, study of the microorganism activity by monitoring differences in biomass temperatures and reducing the time requirement by minimizing fermentation time and minimizing the area requirement by using in-vessel vertical bioreactor. Experiments were carried out to under aeration rate (0.007 m3/min) and particle size of chopped peanut shell (2.0-12.0 mm).Laboratory tests were also executed to examine and evaluate some chemical properties of the raw materials; Temperature profiles; of produced compost.*

Key Words composting; temperature profiles; physical; chemical; microorganism

1. INTRODUCTION

Rapid industrialization and population explosion in India has brought about the migration of people from villages to cities, which generate thousands of tons of MSW daily. The MSW amount is expected to increase significantly in the near future as the country strives to attain an industrialization nation status by the year 2020.The management of MSW is going through a critical phase ,due to the unavailability of appropriate facilities to treat and dispose of the larger amount of MSW generated daily in metropolitan cities. Unscientific disposal causes an adverse on all components of the environment and human health.

1.1 Quantity of Msw

The quantity of MSW generated depends on a various of factors such as food habits, standard of living, degree of commercial activities and seasons. Data on quantity variation and generation are useful in planning for collection and disposal system. Presently, about 90 million ton of solid waste are generated annually as byproducts of industrial, mining, agricultural and other process. The amount of MSW generated per capita is predicated to increase at a rate of 1-1.33% annually. Per capita generation rate of municipal solid waste in India ranges from 0.2 to 0.5kg/day. It is also estimated that the total MSW generated by 217 million people living in urban areas was 23.86 million t/yr in 1991, and more than 39 million t in 2001.The composition of MSW at generation sources and collection points was determined on a wet weight basis and it consists mainly of a large organic fraction (40 to 60%), ash and fine earth (30 to 40 %), paper (3 to 6%) and plastic ,glass and metals (each less than 1%) . the C/N ratio ranges between 800 and 1000kcal/kg . The chemical characteristics of MSW in metro cities.

1.2 Eanut Shell

Peanut shells (PS) are abundant agro-industrial waste products that are recalcitrant to degradation under natural conditions. The increasing expansion of peanut production has led to accumulation of large quantities of these shells all over the world. Globally, 45.6 million metric tons of peanuts are produced annually. It has been estimated that for every kg of peanuts produced, 230-300 g of peanut shells are generated. Therefore, as much as13.7 million metric tons of peanut shells are churned out every year, most of which are dumped into the environment or burned. Peanut shells are a renewable resource that could be targeted for purposeful use in the food, feed, paper and bioenergy industries.

1.3 Composting

Composting was encourage in the initiatives of the government of India (GOI) regarding MSWM focused primarily on promoting composting of urban MSW. The bacterial conversion of organic present in MSW in presence of air under hot and moist conditions is called composting and final products obtained after bacterial activity is called compost (humus) which are very high agriculture value. Composting of peanut shell using effective microorganisms as an accelerator to speed up the composting process and increased nutrients in the compost has not been well documented.

1.3 Objective

- To study and selection of microorganism for fast composting
- Collection of culture media and preparation of effective microorganism (EM) solution
- Characterization of vegetable, fruit waste and peanut shell waste (carbon (C), nitrogen (N), potassium (K), phosphorus (P), temperature, pH, volatile solids)

2. LITERATURE REVIEW

Carlton C et al., (1972) Composting as it is done on cattle feed lots, organic food farms, municipal pilot operations, and

even the back-yard garden was an omnipresent conversational subject at a recent conference, although the formal session on composting was limited to an evening session.

Barton Blum et al., (1992) Composting has been historically promoted as both the basis of the organic method of gardening and farming, and as a waste management technique. Due to economic and public health considerations, however, composting of urban wastes did not achieve wide popularity in Europe until the 1960s and in the United States until the 1980s.

Adam D Read et al Sep., 2001 Municipal Solid Waste (MSW) landfills world-wide are experiencing the consequences of conventional landfilling techniques, whereby anaerobic conditions are created within the landfill waste. Under anaerobic conditions, slow stabilization of the waste mass occurs, producing methane, (an explosive, 'greenhouse' gas) and toxic leachate over lengthy periods of time.

Chukwudi O et al., (2016) composting technology has become invaluable in stabilization of municipal waste due to its environmental compatibility. In this review, different types of composting methods reportedly applied in waste management were explored. Further to that, the major factors such as temperature, pH, C/N ratio, moisture, particle size that have been considered relevant in the monitoring of the composting process were elucidated. Relevant strategies to improve and optimize process effectiveness were also addressed.

3. MATERIALS AND METHODS

In this study, peanut shell is used as the main material for composting together with green waste (vegetable and fruit waste from the market). The peanut shell was soaked in the water for 24 hours before the composting process. All of the raw materials were analyzed for chemical parameters. Composting was carried out in a shaded area at the premises of Premium Agro Products Sdn. Bhd. In this experiment, there are two treatments—compost piles with EM (C1) and compost piles without EM (C2) for control. The mixtures used for all piles were arranged with the ratio as follows: 70% green waste + 30% peanut shell.

Fig -1: Composting of Green Waste with Peanut Shell Waste

3.1Preparation of Culture Media

In this study we used EM (Bacillus subtitles), which contains rod-shaped, and can form a tough, protective endospore, allowing it to tolerate extreme environmental conditions. The EM solution is required for the fast decomposition of waste. Open the bottle containing culture and suspend the pellet with 0.25 ml of LB broth.

Pick up a lapful of culture and streak onto LB agar plate. Incubate overnight at 37c.inoculate a single colony from the revived plate in 10ml LB broth.

Fig -2: Inoculate culture media in broth

3.2 Waste Preparation

The first step in the experimental study was the collection of the chosen fruit wastes. The collection stations a departmental store exclusively for fruits and vegetables and Fruit Market, samples of required quantity were taken. The fruit wastes were collected after the peeling and crushing operations, after which they lose their utility. Rotten fruits were also included in the collection. Before preparation of the composite sample, hand sorting was emphasized to segregate unwanted materials like straw, plastic covers, packaging materials etc. Then a composite sample was prepared and allowed to dry for one week to adjust the moisture content to the desired levels. The dried samples were shredded manually into pieces between sizes 2 and 3 cms. The shredding was done to have good uniformity in heating and to provide greater surface area for microbial attack. The shredded sample was then analyzed for various physical, chemical and biological characteristics to get a rough idea about the biodegradability of the sample.

3.3 Chemical Analysis

The preparation for pH was conducted according to Sundberg et al. and the pH was determined using a digital electrode pH meter. The acidity (pH) of the composting media was measured using pH meter. To measure the pH of composting media, a 5 grams of mixture was placed in a glass beaker (50 cm3), and 30 ml of water was added and agitated together.

3.4 Process Monitoring and Sampling

The process of composting was monitored with great attention. The compost was turned as and when required to ensure uniform mixing and proper aeration. The sampling was done once in four days and the samples were analyzed for nutrient values, physical, chemical and biological characteristics. The nutrient analysis was carried out for the initial waste and the final compost. The collected samples were oven dried, grinded, fine sieved before analysis. The analysis was done for a score of physical and chemical parameters like pH, moisture content, TS, C/N Ratio, COD etc.

4. RESULT AND DISCUSSION

4.1 Temperature Profiles of Produced Compost

Composting process essentially takes place within the two ranges known as methophilic phase (10-40 0C) and thermophiles phase (greater than 40 0C). Although mesophilic temperature allows effective composting, most experts suggest maintaining temperatures between 40 and 58 0C (thermophiles phase) The temperature of the raw materials during composting process is considered as an action indicative of the degree of microbial decomposition activity. Mixing and turning increase aeration by loosening up and increasing the porosity of the composting mixture. The turning frequency scheduling for 2 days once the temperature rate for with EM solution C1 24, 42, 44 (2 week). The temperature rate for without EM solution 24, 42, and 46.

4.2 Chemical Properties of Compost

To promote the growth of microbial populations as a way to increase the decomposition of organic matter during composting, a favorable environment or condition must be provided. The favorable conditions and appropriate loading of microbial nutrients, as well as the nonexistence of harmful toxic compounds, are essential to reach high microbial degradation. The initial pH values of C1 & C2 (7.6) respectively. Which indicates that these residues are non-acidic.

Solution on Day 2 decreasing from the initial values from 6.85 for C1 and 6.98 for C2. The initial pH values for both treatments tended to decrease in the first week The TOC concentration declined slightly for both treatments. The initial values of TOC were 38.44% for C1 and 27.68% for C2. The initial C/N ratio for C1 was 9.33, while for C2 it was 9.99.

The initial value of N in early composting was 4.12% for C1 and 2.77% for C2 the initial P value was 0.37% for C1 and 0.32% for C2.

Table -1: Chemical parameters for c1

week	pH	TOC	N	C/N	K	P	Temperature
0	4.51	38.41	4.12	9.33	0.66	0.37	24
1	5.03	43.06	1.27	33.9	3.12	0.15	45
2	6.14	44.44	1.76	25.25	3.89	0.27	47

Table -2: Chemical parameters for c2

week	pH	TOC	N	C/N	K	P	Temperature
0	4.51	38.41	4.12	9.33	0.66	0.37	24
1	5.63	40.16	1.28	31.62	4.53	0.12	43
2	7.73	43.46	1.98	21.94	4.78	0.22	45

The initial value of P for C1 and C2 is 0.37 it gradually increases due to presences of microorganism.

4.3 Bio-Degradation of Mixture 1:2

For the waste mixture, 1:2 the bio degradation was studied by analyzing various parameters of the composted samples once in four days.

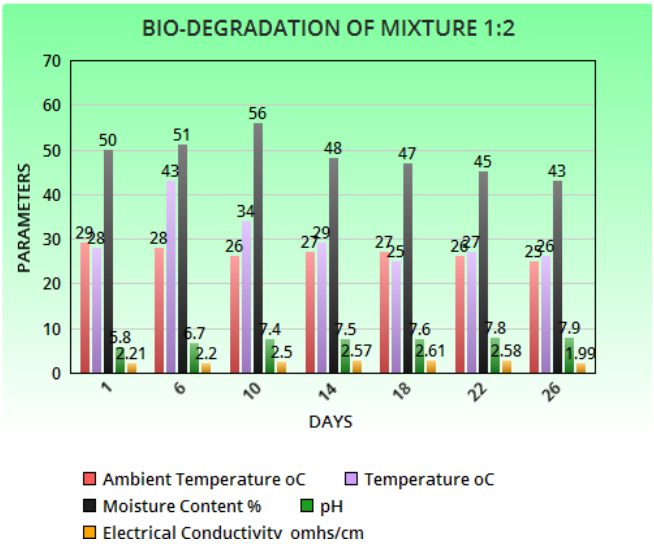

Chart -1: Bio-degradation of mixture 1:2

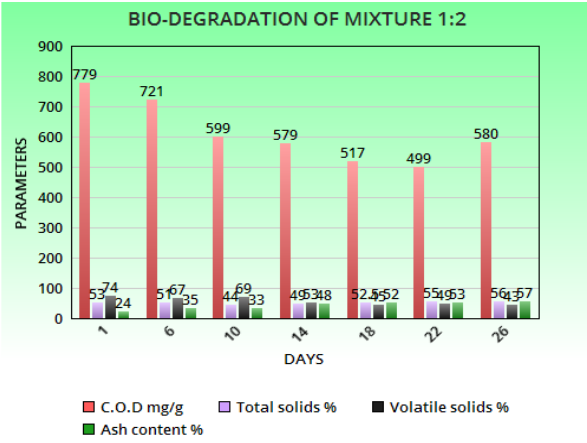

Chart -2: Bio-degradation of mixture 1:2

4.4 Bio-Degradation of Mixture 1:3

For the waste mixture, 1:3 the bio degradation was studied by analyzing various parameters of the composted samples once in four days.

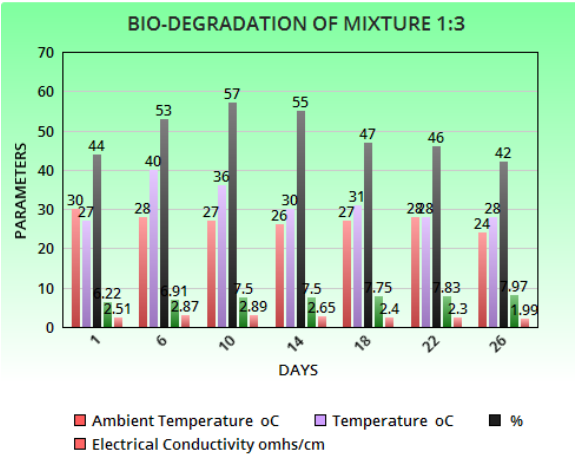

Chart -3: Bio-degradation of mixture 1:3

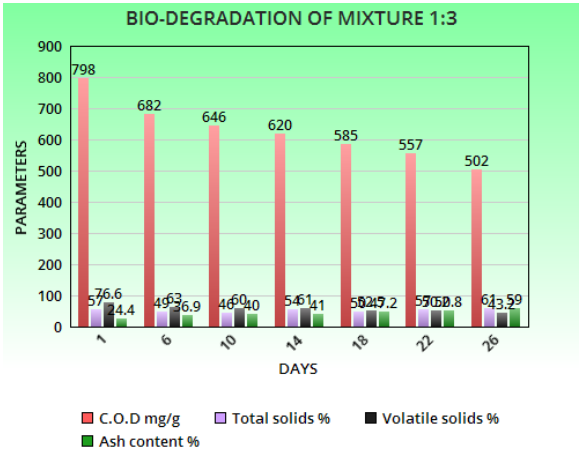

Chart -4: Bio-degradation of mixture 1:3

4.5 Bio-Degradation of Mixture 1:4

For the waste mixture, 1:4 the bio degradation was studied by analyzing various parameters of the composted samples once in four days.

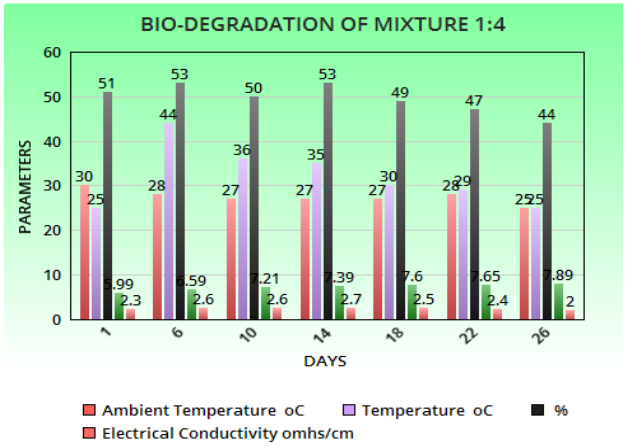

Chart -5: Bio-degradation of mixture 1:4

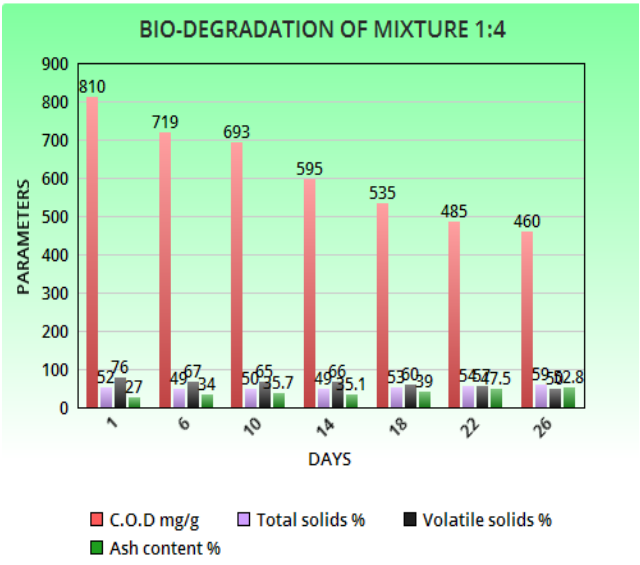

Chart -6: Bio-degradation of mixture 1:4

4.6 Bio-Degradation of Mixture 1:5

For the waste mixture, 1:5 the bio degradation was studied by analyzing various parameters of the composted samples once in four days.

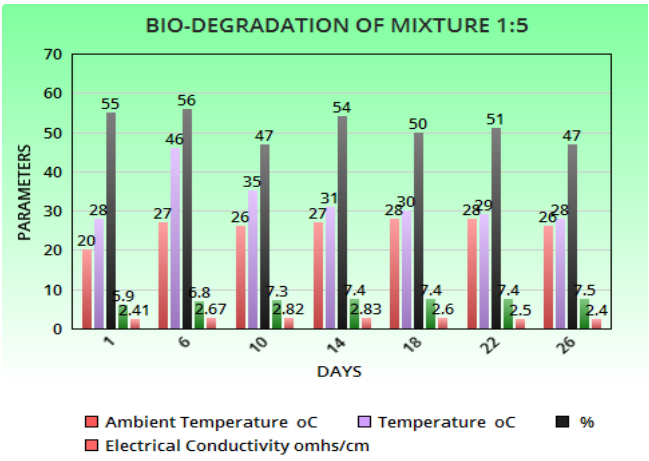

Chart -7: Bio-degradation of mixture 1:5

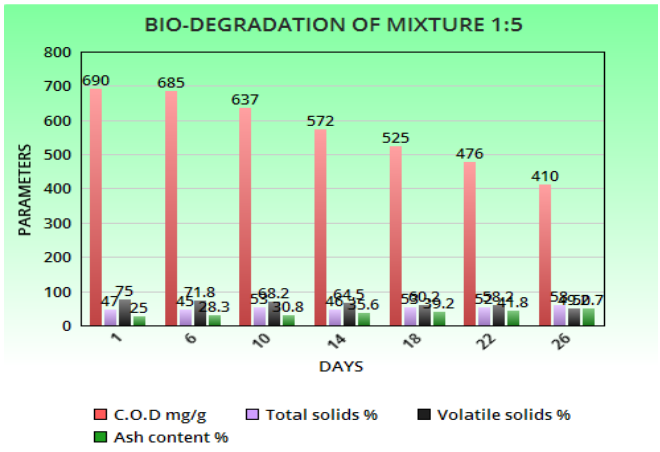

Chart -8: Bio-degradation of mixture 1:5

4.7 Nutrient Values of Waste – Before and After Composting

The nutrient values of the chosen fruit waste before (waste) and after composting (compost) for different mixtures in different reactors were analyzed and are the values are provided below

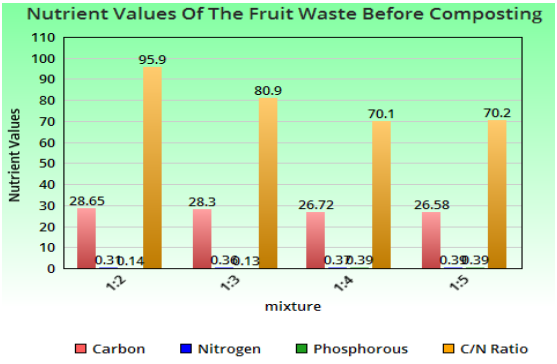

Chart -9: Nutrient values of waste – before and composting

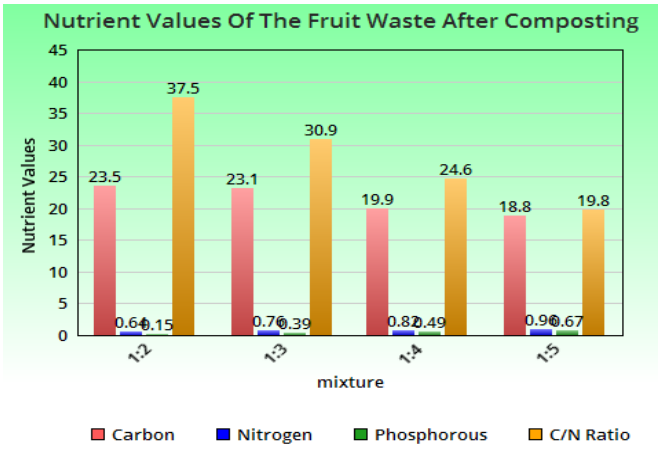

Chart -10: Nutrient values of waste – After and composting

CONCLUSION

This study aims to assess the effect of EM application on the composting process of peanut shell with cow dung manure and green waste and to evaluate the quality of both compost treatments. There are two treatment piles in this study, in which one pile was applied with EM and another pile without EM. Each treatment was with 56 days of composting duration. The parameters for the temperature, pH, TOC and C/N ratio, show that decomposition of organic matter occurs during the 56 day period. The application of EM in compost increases the macro and micronutrient content. This study suggests that the application of EM is suitable to increase the mineralization in the composting process. The Experimental study of biodegradation of fruit wastes using techniques of aerobic composting has established the following significant details .In the bio -degradation of fruit waste by In-vessel Non flow Reactor Type the process of composting is significantly affected by constituents like C/N ratio, moisture content, COD, pH, electrical conductivity, total solids and temperature. The Composting process proceeds at a fairly quick rate (26 Days) with forced aeration of 1 lit/kg/min. From the analysis of C/N ratio, the reduction was great for mixtures 1:3 and 1:4, which implies that addition of excessive carbon content, is not encouraged. Moreove r the final C/N ratio for the mix 1:5 (19.8) is indicative of the completion of composting in 26 days. All the same, if easily viable the aerobic composting of fruit wastes by the suggested methods may prove a handy solution for the society.

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